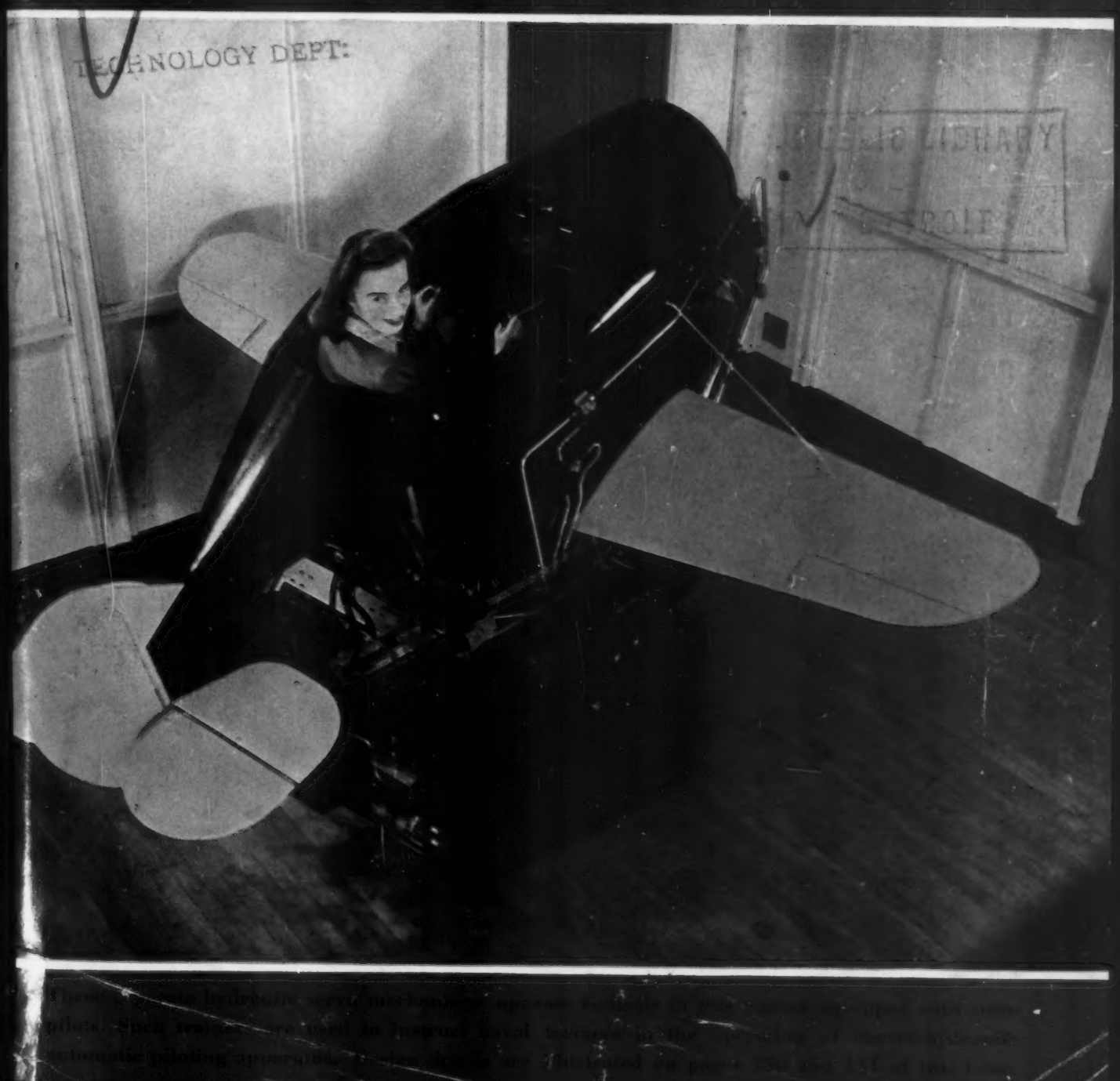
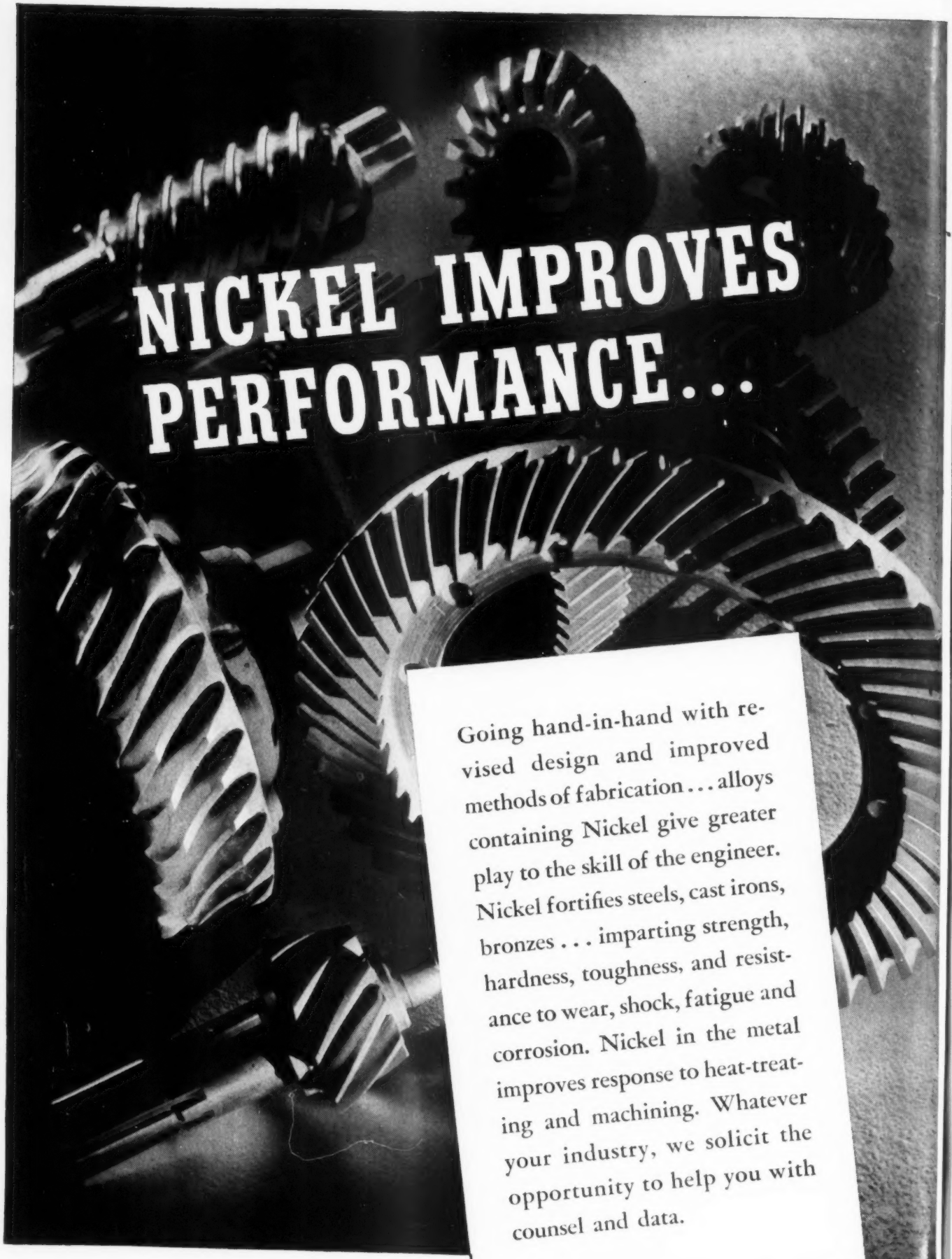
PRODUCT ENGINEERING

JULY, 1945





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PRODUCT ENGINEERING

VOLUME XVI — JULY, 1945 — NUMBER 7

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IN THIS ISSUE

Cover Picture—Trainer equipped with automatic pilot control. Kodachrome courtesy General Electric Company.

Postwar Technical Research

Many of our leaders in both government and industry have recognized the need for continuing scientific research in armament. Early in this war, at the request of the Secretaries of War & Navy, the Wilson committee was formed to study the postwar research and development needs of the

Army and Navy. Its Congressional counterpart, the Woodrum committee, is trying to determine the specific form that an organization to direct such activities should take. On page 433 the formation of the Research Board for National Security, as one answer to the problem, is discussed.

More Efficient Heat-Treating

With highly alloyed steels not readily available under wartime restrictions, NE and intensified steels are being pushed and will continue to be used after the war. Among the heat-treating methods especially suited for these steels is martempering which is described by B. F. Shepherd, chief metallurgist of Ingersoll-Rand, on page 438, in an article which leads from the fundamental considerations to actual performance data, showing the mechanical and metallurgical advantages of the process.

Strain Gage Technique

Until about 5 years ago, there was no gage available combining features of simplicity, low cost, lightweight, remote indication and high accuracy for both static and dynamic strain measurement. E. E. Simmons of the California Institute of Technology, about 1939, devised an ingenious method for making use of fine resistance wire to measure strain. The usefulness of these resistance wire gages was quickly recognized by Prof. A. V. DeForrest at Massachusetts Institute of Technology. A great deal of effort has since been expended in devising suitable methods for their application. Techniques for the use of resistance wire strain gages at the Douglas Aircraft for stress-strain analysis are described by E. G. Van Leeuwen and W. F. Gunning on page 443. The associated equipment for static and dynamic strain measurements will be described in a succeeding article.

Drawing Release

In a continuing series of articles, James E. Thompson, chief engineer, Booth Manufacturing Corporation has discussed the organization of an engineering department, personnel and cost control, planning and coordination (see PRODUCT ENGINEERING, March, May, June 1945). In this month's installment, page 465, the author proposes practical methods for proper control of drawings, release procedures, records and change requests.

Elliptic Gears for Quick Return Mechanisms

Many machine tools, packaging and folding machines do their work intermittently on the stroke of a reciprocating member that is driven by a quick return mechanism. In this field of design, the use of elliptic gears offers some advantages. F. H. Miller and C. H. Young, Cooper Union School of Engineering, see page 462, discuss a procedure for determining the proportions of two elliptic gears of the same size to produce a specified quick return ratio.

Cup and Flange Packing Design

Successful application of cup and flange packings depends greatly upon observance of rules for design that have been determined by long experience. The principal features of correct design, presented by Everett H. Clark, Graton & Knight Company, are illustrated on pages 474 and 475 by fourteen typical applications.

Elongation in Spars Caused by Riveting

To determine the causes of elongation in long aircraft spars during fabrication, an investigation was conducted by the manufacturing research department of Consolidated Vultee Aircraft Corporation. C. H. Smith, see page 471, describes the procedure followed in several tests and reports some interesting observations on the effects of rivet proportions, rivet heading pressure and rivet expansion as contributing causes in the growth of spars.

Safety Features in Machine Tools

Recent improvements in the design of machine tools bear evidence of the efforts of designers to eliminate accident hazards in the operation and maintenance of machines, to reduce fatigue, and to prevent breakdowns caused by inept handling. A. William Meyer, assistant director of design, Brown & Sharpe Manufacturing Company, see page 476, discusses these several design objectives and describes some safety and fatigue reducing features that have been incorporated in machine tools.

Workability of 75S Aluminum

Fabricating characteristics of 75S aluminum, such as forming qualities, importance of heat-treatment, and possibilities of welding, had to be determined almost before the material was available for use. Because of the urgency of using the best combination of strength and light weight in aircraft, Northrop went after the answers to fabrication problems even before the material was commercially available. Results of the investigations and experiences are discussed by M. Raskin, Northrop's assistant chief process engineer, in the article beginning on page 481.

Hydraulic Power Systems

For convenience of discussion Howard Field, Jr. has divided hydraulic systems into two parts; the power system, and the distribution system. Starting on page 485 the author in the seventh of his series of articles discusses the characteristics, types and applications of basic hydraulic power systems. Examples are included to point out the difficulty of combining these systems when more than one characteristic is required. The next article of this series will discuss distribution systems.

Physical Properties of Cellulosic Plastics

Graphs of physical data for cellulose acetate and high acetyl molding materials of different formulations plotted for ranges of dry flow temperatures. Data contributed by Celanese Plastics Corporation, see page 503, Reference Book Sheets.

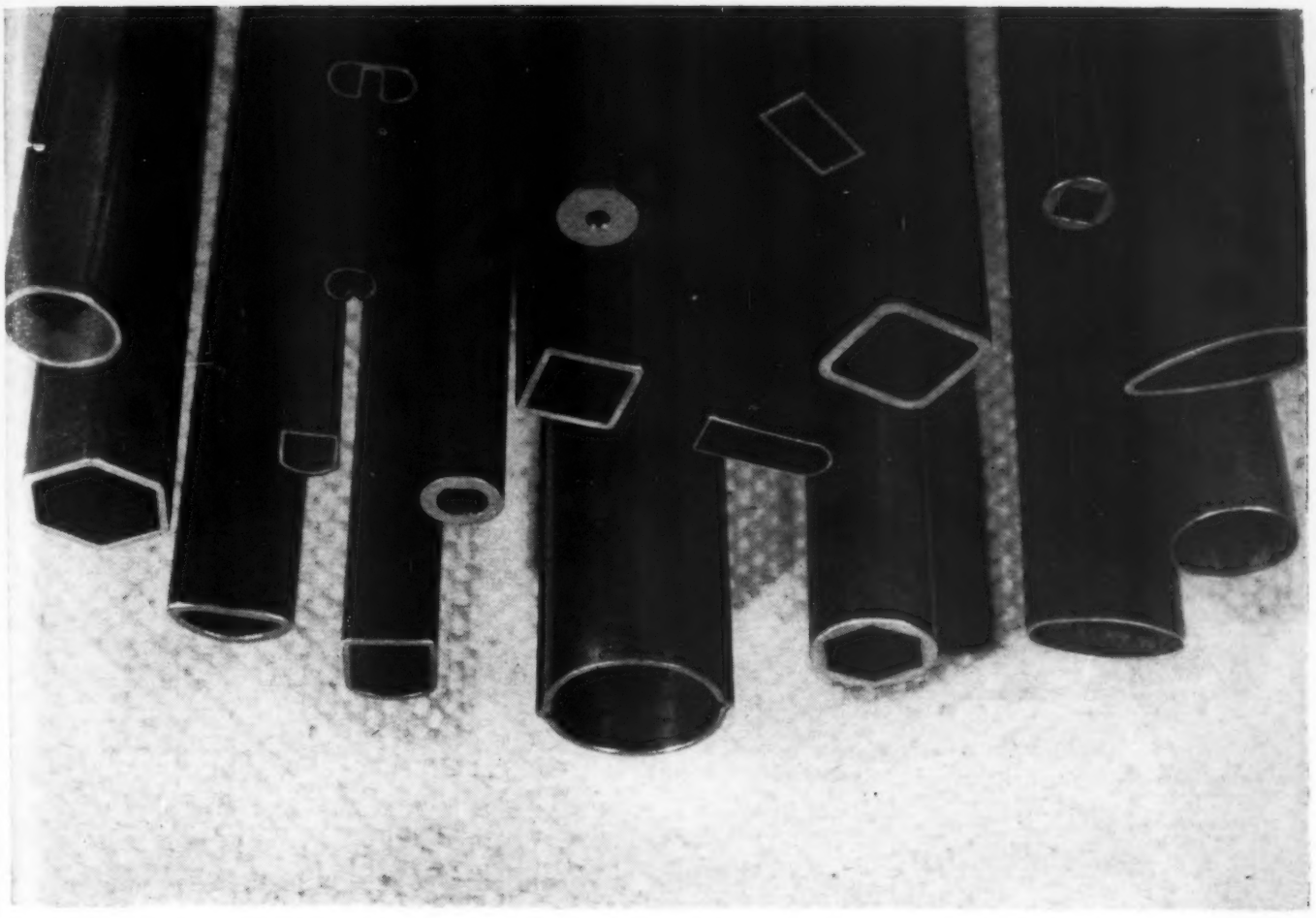
AUGUST HIGHLIGHTS

Stress Raisers, by B. C. Boulton. Effect of structural discontinuities on the distribution of stresses.

Analysis of Gear Tooth Contact, by Fred Bohle. Line of action drawings based on actual machine processes and tools used in cutting gears.

Flash-Butt Welds, by J. J. Riley, Taylor-Winfield Corporation. Applicability and design standards for flash-butt welding average and highly stressed parts are presented.

Hydraulic Distribution Systems, by Howard Field, Jr. Discusses the types, characteristics and combinations used in hydraulic distribution systems.



19 Good Reasons—

• There is an individual success story for each of the 19 special Summerill seamless steel tube sections shown above—but space does not permit giving you the details here. Furthermore, these items are merely representative of the hundreds of special sections which we have produced for industry over the years.

There is, however, a common denominator for Summerill specials in seamless steel tubing. Each is designed to do a job better, quicker or at lower cost.

In pre-war days we were able to help numerous companies to find new and improved ways to produce parts for products that ranged from intricate machines to sporting goods. In the competitive days that will follow the swing to civilian production, we will be in a still better position to help you because of our war-earned experience, skills and facilities. Why not discuss your problems of "tomorrow" with Summerill, today.

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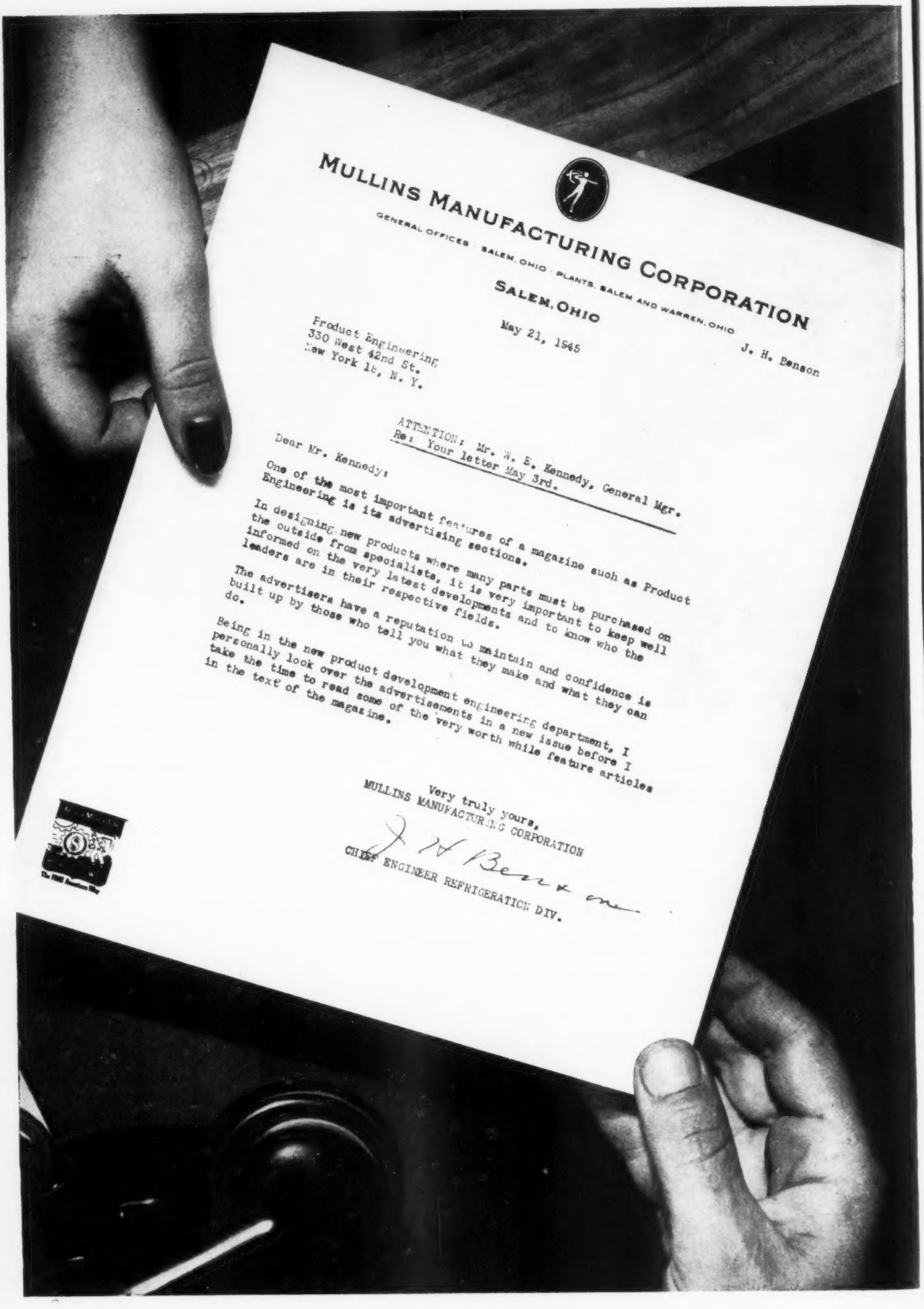

MULLINS MANUFACTURING CORPORATION

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SALEM, OHIO

May 21, 1945

J. H. Benson

Product Engineering
330 West 42nd St.
New York 18, N. Y.

ATTENTION: Mr. W. E. Kennedy, General Mgr.
Re: Your letter May 3rd.

Dear Mr. Kennedy:

One of the most important features of a magazine such as Product Engineering is its advertising sections.

In designing new products where many parts must be purchased on the outside from specialists, it is very important to keep well informed on the very latest developments and to know who the leaders are in their respective fields.

The advertisers have a reputation to maintain and confidence is built up by those who tell you what they make and what they can do.

Being in the new product development engineering department, I personally look over the advertisements in a new issue before I take the time to read some of the very worth while feature articles in the text of the magazine.

Very truly yours,
MULLINS MANUFACTURING CORPORATION

J. H. Benson

CHIEF ENGINEER REFRIGERATION DIV.

New! Free-Cutting Copper Rod

...by Revere increases production

To meet the demand of the electronic and electrical industries, the welding equipment field, and in fact of all companies needing copper of improved machinability, Revere now offers Revere Free-Cutting Copper Rod.

This is oxygen-free, high conductivity copper containing a small amount of tellurium, which greatly increases the speed with which the metal can be machined, makes it possible to hold to closer tolerances, and improves the finish of the completed parts. Electrolytic copper, while suitable for many purposes characteristically machines with long tough stringers which are difficult to remove. Free cutting copper chips are brittle and break readily, clearing from the tools without attention.

These advantages increase production rates, depending upon the amount of machining necessary on each given part. Consequent lowered costs may be an important factor to you.

Revere Free Cutting Copper Rod is available in sizes up to 2" and in all the usual shapes. For details, write the Revere Executive Offices.

CUSTOMERS REPORT:

"This material seems to machine much better than our previous hard copper bar; it cuts off smoothly, takes a very nice thread, and does not clog the die." (Electrical parts.)

"Increased feed from 1½" to 6" per minut. and do five at one time instead of two." (Switch parts.)

"Spindle speed increased from 924 to 1161 RPM and feed from .0065" to .0105" per spindle revolution. This resulted in a decrease in the time required to produce the part from .0063 hours to .0036 hours. Material was capable of faster machine speeds but machine was turning over at its maximum. Chips cleared tools freely, operator did not have to remove by hand." (Disconnect studs.)

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

Executive Offices: 230 Park Avenue, New York 17, N. Y.

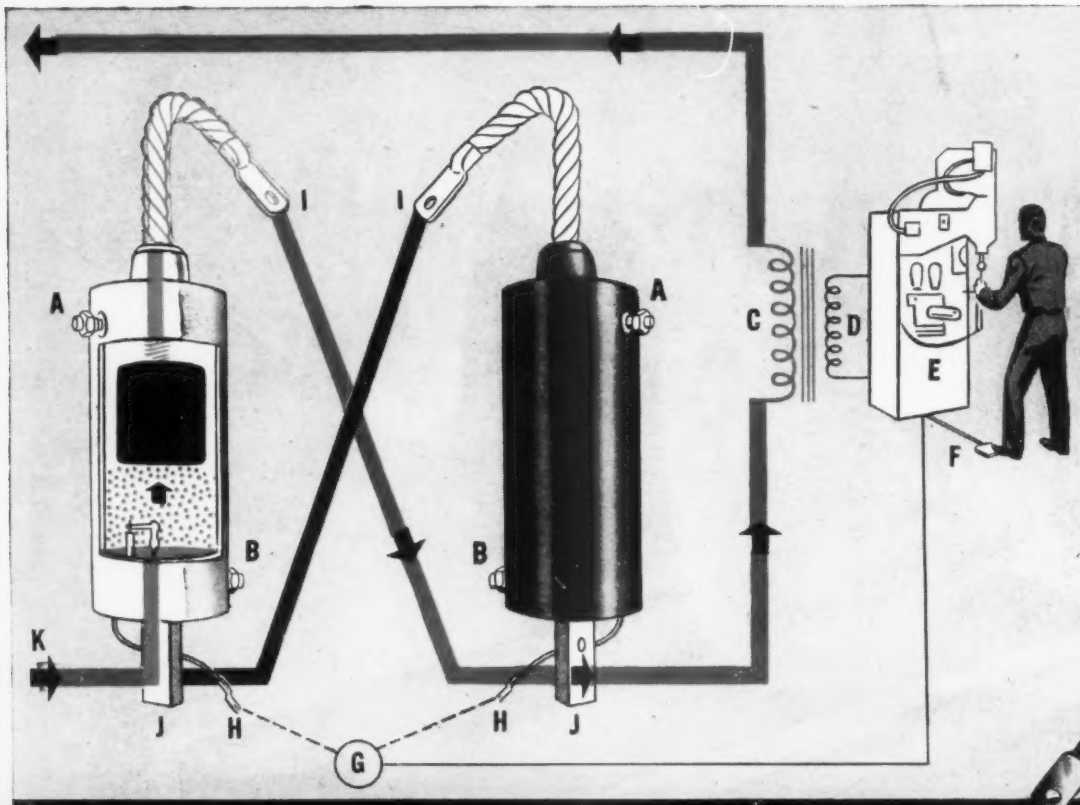

Diagram shows how the welding-machine operator starts and stops current-flow instantaneously by excitation of G-E ignitrons. The two tubes are reverse-coupled, so that each one handles half of the a-c power cycle.

A. Water connections
B. Water connections
C. Welding transformer primary
D. Welding transformer secondary
E. Resistance welder machine
F. Weld initiating switch
G. Ignitor excitation and control circuit
H. Ignitor connections
I. Anode connections
J. Cathode connections
K. A-C power supply.

IGNITRONS "trigger" the heavy currents for resistance welding

AN important use of G-E ignitron tubes is shown above—controlling the primary current of resistance welders. The same benefits of split-second, positive "valve" action, with no mechanical linkage and no arcing between movable contacts, are provided by G-E ignitrons for other control circuits—furnace, motor, etc.—involving heavy electrical currents.

● Current control is but one of this tube's functions in industry. Another is current conversion—a-c to d-c. Here ignitrons offer the advantages of silent operation, no rotating parts, no need for lubrication, no mechanical upkeep.

● Steel-jacket construction and mercury-pool type cathode, among other features, make the G-E ignitron sturdy, dependable, and long-lived. Learn more about this versatile electronic tube from G.E.'s new Booklet ETI-21, "Ignitron Tubes and How They Are Used." Its 24 profusely illustrated pages, complete with selected circuits, tell the full story of ignitrons and how they serve industrially. Your free copy is waiting. Telephone TODAY your nearest G-E office or distributor, or write to *Electronics Department, General Electric, Schenectady 5, N. Y.*

Hear the G-E radio programs: *"The World Today" news, Monday through Friday, 6:45 p. m., EWT, CBS. "The G-E All-Girl Orchestra," Sunday 10 p. m., EWT, NBC. "The G-E House Party," Monday through Friday, 4 p. m., EWT, CBS.*

IGNITRON FG-235-A . . . $75.

This tube is one of the most widely used G-E ignitrons. It is a steel-jacketed, water-cooled, gas-filled triode with mercury-pool cathode, used for welder and other heavy current controls, and as a low-power current converter. For welder-control service, ratings are: max kva demand 1,200, with corresponding avg anode current 75.6 amp—max avg anode current 140 amp, with corresponding kva demand 400. (These ratings are for voltages of 600 v rms and below.) Ignitor requirements are 200 v and 30 amp. . . . Ratings for current conversion will be supplied on request, in which case please include a brief description of the application or circuit.

G.E. HAS MADE MORE BASIC ELECTRONIC TUBE DEVELOPMENTS THAN ANY OTHER MANUFACTURER

GENERAL ELECTRIC

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TRANSMITTING, RECEIVING, INDUSTRIAL, SPECIAL PURPOSE TUBES ★ VACUUM SWITCHES AND CAPACITORS

New glass and rubber belts stand heat 4 times better

A typical example of B. F. Goodrich development in rubber

THIS endless pre-formed board of glass-fiber insulation for the Navy is moving out of the furnace at 300° F. It's a continuous operation, so a conveyor belt was needed to carry it away and let it cool. But the heat charred the cotton cords in every belt used — every few weeks the belt had to be removed, and that meant loss of production by shutting down this conveyor line. And in normal use the belts stretched, and had to be taken up every day.

Fiberglas and B. F. Goodrich engineers got together and worked out a belt using plies of glass fabric instead of cotton. But oil had to be sprayed on the glass insulation, and this would ruin rubber. So B. F. Goodrich developed a synthetic cover that resists both the oil and the intense heat.

They made a wide belt of the new construction, then split it into narrow belts strong enough to carry the burden but leaving air spaces for quicker cooling.

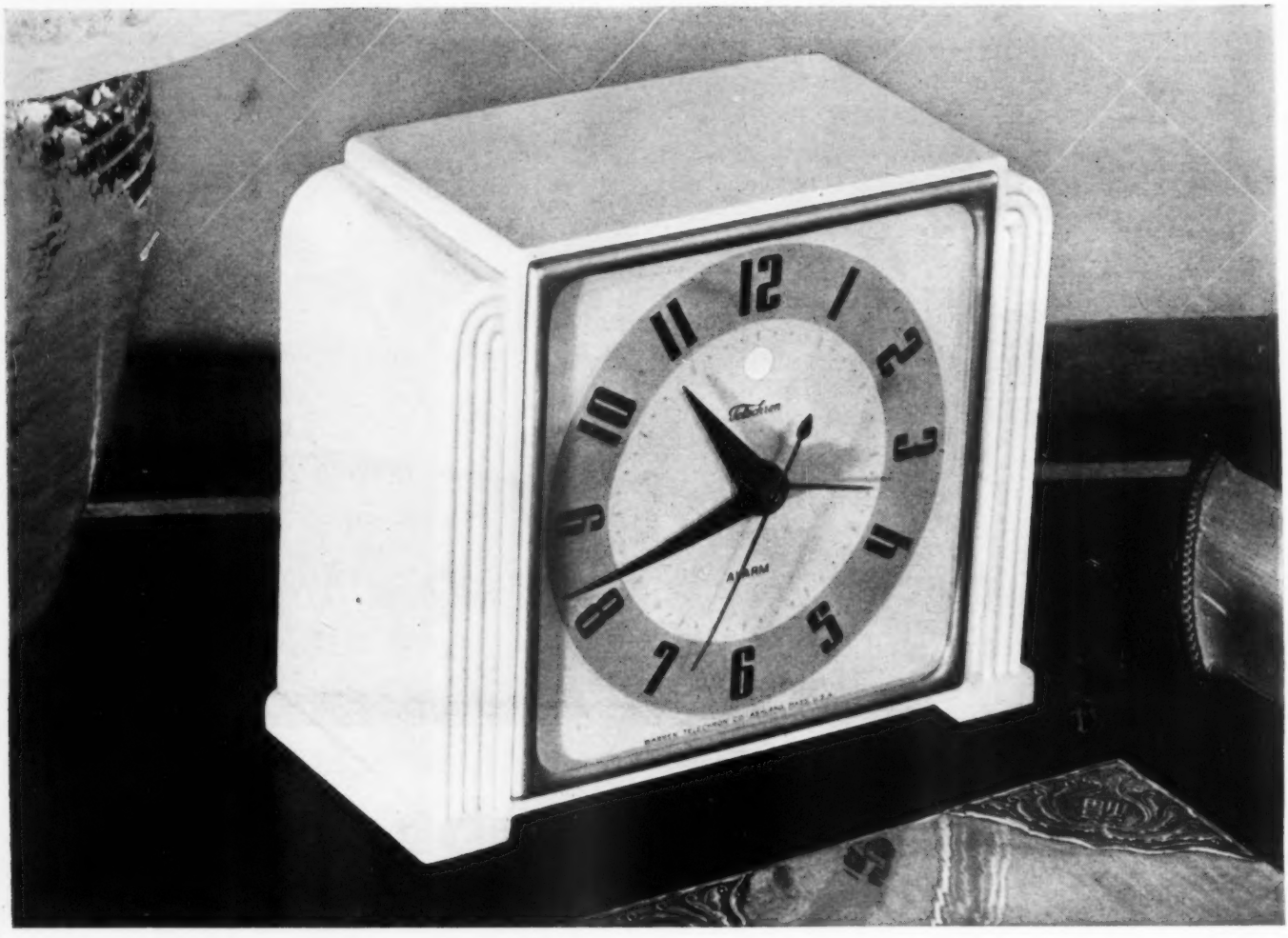
The new belts have already lasted 6 months—4 times as long as the former belts — and look good for months more. And stretch has been practically eliminated — in the 6 months these new belts have had to be taken up only twice. Cost has been reduced, continuous production of vital material made possible.

This new belt construction in which B. F. Goodrich has practical experience can be of value in many postwar applications where heat is present and where low stretch is important. It illustrates why hundreds of users come to B. F. Goodrich first to have problems solved and to find improved products in all the industrial rubber goods they use. *The B. F. Goodrich Company, Industrial Products Division, Akron, Ohio.*

B. F. Goodrich

RUBBER *and* SYNTHETIC *products*

Beetle ...sells



This Telechron electric alarm clock with ivory BEETLE *case is now being made by Warren Telechron Company and will soon be on sales counters throughout the country. Telechron clock housings are molded by Northern Industrial Chemical Co. and General Electric Plastics Divisions.*

BUTTONS molded of BEETLE appeal to customer, retailer, and manufacturer alike, because of their absolute uniformity and smooth, attractive finish that doesn't crack or craze, chip or peel.

HOUSINGS for barometers, thermometers, and other instruments, withstand wear and abrasion caused by constant handling when molded of smooth, shatter-resistant BEETLE.

All the time!

Customers may be more plentiful than clocks just now, but there's always magic sales appeal to a product housed in BEETLE*. For the plastic, BEETLE, has the charm of color, the pleasantness of texture, the lastingly beautiful finish to create and satisfy customers.

There's also "customer-value" appeal with BEETLE because smart, quality appearance can be achieved on a low-cost, volume production basis to enable your product to compete profitably in the desired price range.

And BEETLE housings give needed protection to clockworks, instruments, radio sets, electric razors, and other mechanisms. For BEETLE is both thermally and electrically insulating. It can be molded to close tolerances of your own requirements.

Information about BEETLE, *the plastic that's all color in all colors* to style your line for modern-day consumer appeal, will be supplied on request.

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Beetle · Melmac
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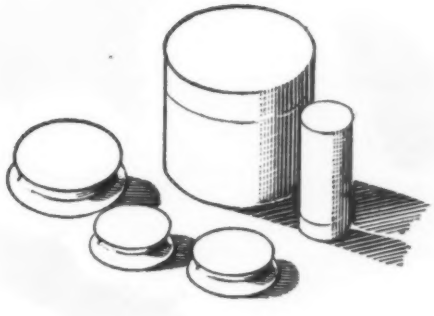
ILLUMINATED DISPLAYS, trade-marks, and signs in translucent colorful BEETLE are singularly brilliant, give pleasantly diffused light, and lead the customer straight to the point of sale.



COSMETIC CONTAINERS, jewelry boxes, and closures molded of colorful BEETLE, have quick customer appeal, sales-stimulating beauty and utility, so essential for ideal packaging.

How many spots in communications equipment can you find for this newest MICARTA product?

Here's a new boost, and a challenge, to communications and electronic designers . . . coil forms from Micarta "444", the latest Westinghouse development in industrial plastics.

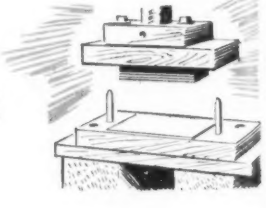
These strong, lightweight forms provide greater freedom in production due to the insulating characteristics and resistance to heat, cold, humidity and chemicals—characteristics found in *all* Micarta plastics. Both small and medium size forms can be economically made from Micarta "444" for small-run production jobs.

Micarta "444"—a phenolic resin with a fabric base—is easily formed on inexpensive and quickly-constructed plastic or wooden dies. A simple arbor press with only 100 pounds per square inch pressure can do the job handily. Micarta "444" can be formed or bent into a variety of shapes from flat, cured sheets with perfect uniformity (see examples above).

Micarta "444" has already found many uses in radio and communications equipment. How many can you find in your product designs? Your nearest Westinghouse office will be glad to explore its possibilities with you. Or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

J-94667

JUST HEAT . . . premolded and cured sheets are heated uniformly on both sides by infrared lamps for specified time.



TRANSFER . . . heated sheet is then quickly placed in inexpensive wood mold in arbor press or where pressure can be applied to mold.

AND FORM . . . pressure of about 100 psi is applied and shape cooled briefly in mold.

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

. . . one of many Westinghouse contributions to progress in electronic and communications equipment design

Micarta "444" is one of many Westinghouse products developed especially to meet engineers' demands for their new designs.

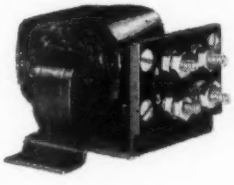
Here is a quick check list of some important Westinghouse developments . . . what they are, where to use them, what they will do. Like Micarta, each possesses characteristics giving designers greater freedom and flexibility.

Your nearest Westinghouse office can give you complete data on any of these exceptional communications products. Ask for the book number shown in parentheses on each item.

A QUICK CHECK LIST OF SOME WESTINGHOUSE COMMUNICATIONS PRODUCTS

MATERIALS

Hipersil Cores . . .



Ready - to - assemble Hipersil cores have ⅓ greater flux-carrying capacity and eliminate time-wasting stacking of tissue-thin laminations by hand. (B-3223-A)

Tuffernell Insulating Materials . . .

Developed during 50 years of field experience, Westinghouse "Tuffernell" insulating materials supply the *right* grade needed for numberless communications jobs. (B-3322-A)

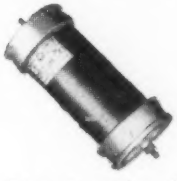
Solder-Seal Prestite . . .

New high-strength Zircon Prestite offers remarkable versatility for communications products . . . it has low loss, high resistance to thermal and mechanical shock and can be supplied with standard Solder-Seal for true hermetic joining to metals. (B-3244)

EQUIPMENT FOR THE COMMUNICATIONS INDUSTRY

PARTS AND ASSEMBLIES

Inerteen Capacitors . . .



Light weight, small volume and high reliability are features of Inerteen Capacitors for d-c service at 400 to 250,000 volts. Inerteen—the liquid dielectric is noninflammable . . . nonexplosive. (B-3300)

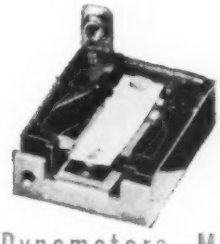
Electronic Tubes . . .

Uniform, trouble-free, long-life service is built into every electronic tube in the Westinghouse line . . . Pliotrons, Kenotrons, Phototubes, Thyratrons and Ignitrons. (SP-204)

Instruments . . .

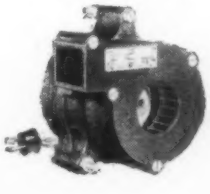
Westinghouse instruments range from miniature panel size to 4-foot boiler room indicators for all types of mountings. (B-3283)

Thermostats . . . Heaters . . .



If it takes electric heat, Westinghouse can help solve the control problem with a well-stocked line of thermostats that will handle any job up to 650° F. The tiny thermostat illustrated is for final temperature control in a crystal oven. (B-3344)

Dynamotors, Motors and Blowers . . .



Smooth, functional design gives these rotating components high flexibility for radio equipment. Light weight and compactness are the keynotes in the design of these long-lived devices. Available for a wide range of frequencies and voltages. (B-3242)

Designer's

The fractional-hp motor with BIG-MOTOR features

Here's a motor specifically designed and built for use on machine tools and other industrial equipment where frequent start-stop service or plugging is required, or where adverse atmospheres are encountered.

It has a sturdy "big-motor" mounting base that facilitates precise alignment, and makes that alignment *permanent*. It has a one-piece rotor winding of cast aluminum that is practically indestructible. It has rigidly anchored stator windings of Formex* wire that stay put despite repetitive stop-and-go service, momentary overloads, and plugging.

The ball bearings on this G-E machine-tool fractional-hp motor are of a design to meet the requirements of thrust loads.

End-mounted motors are available in three types: with machined-rabbet end shield; flat-face end shield; flange-type end shield.

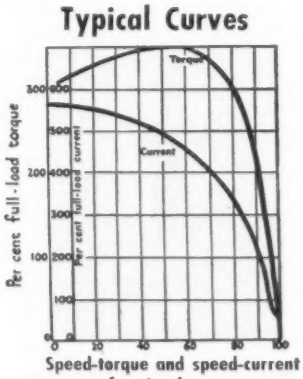
G-E Type K motors are for constant-speed a-c, three-phase service; they provide normal starting and high maximum torques. Type K motors are available in ratings of $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, and $\frac{3}{4}$ hp; 1725 rpm at 60 cycles; 1425 rpm at 50 cycles; 220/440 volts and 550 volts.

G-E Type BC motors are for d-c service and have characteristics comparable with those of the Type K. They are available in the same horsepower ratings; 1725 rpm; 115 and 230 volts.

Other electrical types and ratings can also be furnished. Let us know your requirements.

*Trade-mark reg. U. S. Pat. Off.

Typical Curves



Speed-torque and speed-current curves for 4-pole, a-c motors

CAST BASE insures accurate, lasting alignment.

•

TOTALLY ENCLOSED construction keeps out dirt, metal dust, coolants.

•

RIGIDLY HELD WINDINGS withstand strenuous start-stop service.

•

BALL BEARING construction allows mounting in any position.

•

CONVENIENT TERMINAL BOX permits permanent connections to be made quickly.

BUY WAR BONDS

GENERAL ELECTRIC

Digest

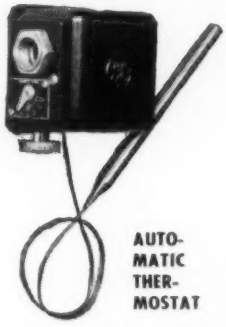
TIMELY HIGHLIGHTS ON G-E PRODUCTS

TO RECORD HOURS OF OPERATION

TYPE KT TIME METER

Our Type KT time meters provide the ideal way to keep an accurate record of the total operating time of punch presses, molding machines, refrigerators —almost any electrically driven machine. They can be furnished to match the operating characteristics of the machine, and to measure time in hours, tenths of hours, or minutes.

Powered by accurate Telechron synchronous motors. Supplied with plastic or metal case, to harmonize with other G-E instruments mounted with them, and either round or square. Bulletin GEA-3299.



AUTOMATIC THERMOSTAT

THERMOSTATS WITH A PLUS

G-E automatic thermostats are available in a variety of types and temperature ranges, sufficient to cover nearly any application. For example, the type shown is available in adjustable temperature ranges as low as 30 to 120 F, and as high as 500 to 750 F. Current capacity is up to 25 amperes a-c, 115/230 volts. Higher currents and voltages are handled with the aid of G-E contactors.

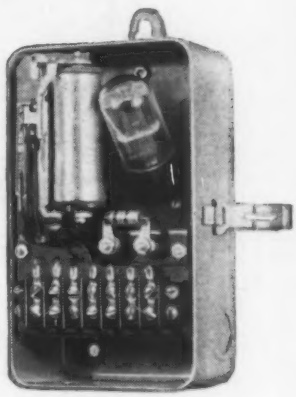
These thermostats are highly resistant to vibration and well suited for use on linotype and other machines that give thermostats a beating. Their compact switch design and the use of a remote bulb allow you to locate them where most convenient.

MINIATURE OSCILLOGRAPH

The G-E Type PM-17 oscillograph will make a permanent fine-line photographic record of six simultaneous variations of different machine phenomena. It is little more than a foot in length, weighs but ten pounds, and has sensitivities of 1.7, 8, 17, and 31 milliamperes per millimeter, with usable frequencies up to 4 kilocycles. All of the essential elements of a recording magnetic oscillograph are included. Write for Bulletin GEA-4331.

Buy all the BONDS you can—
and keep all you buy

Note the *versatility* of this electronic relay



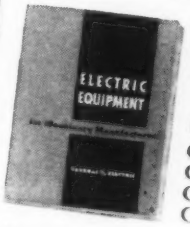
ELECTRONIC RELAY

Here is a reliable electronic relay specially designed to give consistent operation even when the contact-making medium may introduce a resistance of up to 5 megohms (5,000,000 ohms). It may also be used where the controlling contacts remain closed for only a few thousandths of a second duration. These contacts operate without pitting, arcing, or sticking.

With this sensitive G-E relay, the contact-making medium may be a damp thread, moisture or condensation, a column of mercury, or a solution of milk, salt, or other conductive solution. It is also readily operated by contact-making instruments.

The contacts on the magnetic relay in the unit, which is actuated by the electronic tube, are rated one ampere at 115 volts a-c. These contacts can be used to operate external lights or auxiliary relays which, in turn, operate motor starters or other devices.

This compact, weather-resistant G-E electronic relay (only 7½ by 5½ by 4½ in.) is finding increasing application as a stop switch in textile mills, for liquid-level control, counters, temperature control, inspection, and other industrial jobs. Send for Bulletin GEA-4214.



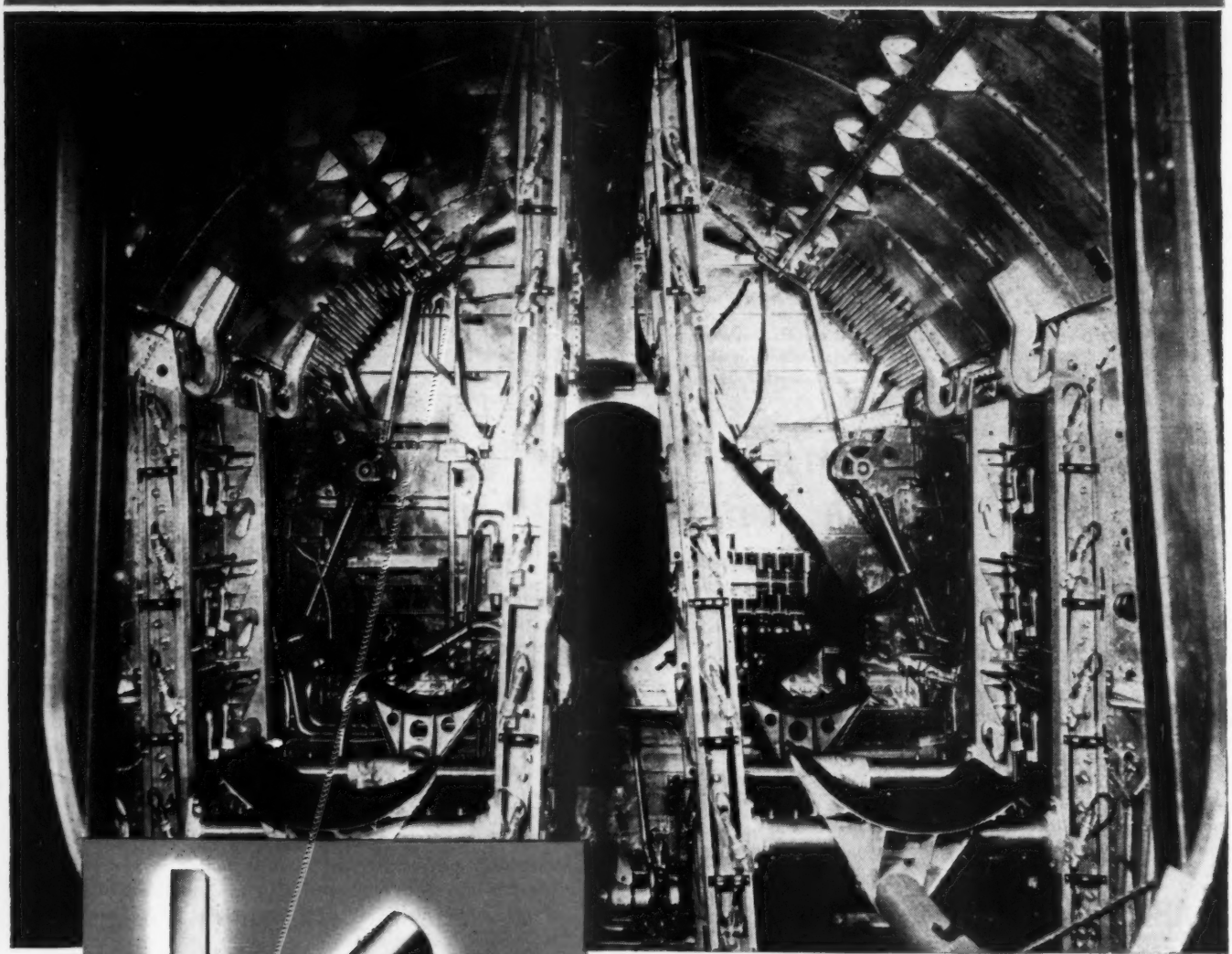
To General Electric Company
Section 668-41, Schenectady, 5, N. Y.
Please send me the following bulletin(s):

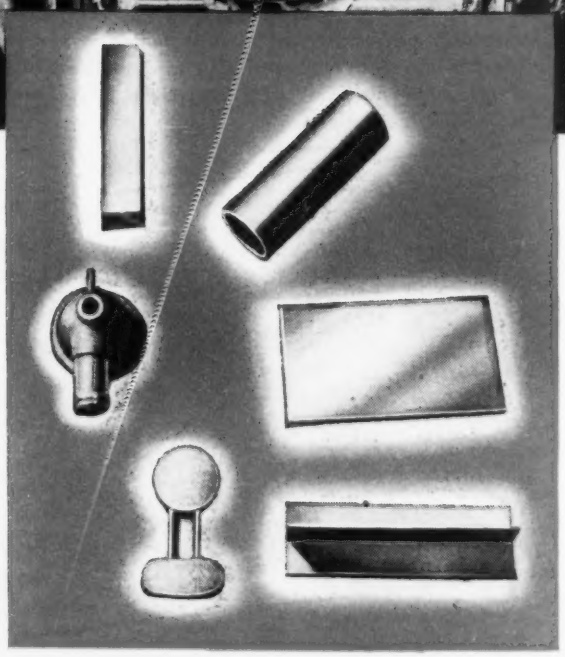
GEA-4102A—F-hp Motors .....
GEA-3299 —Time Meters .....
GEA-4331 —Oscillograph .....
GEA-4214 —Electronic Relays ....

Name .....
Company .....
Street .....
City ..... State .....

668-41-8579

How UP-TO-DATE are you on ALUMINUM?





Photos, courtesy Glenn L. Martin Company

HERE IS THE BOMB BAY of a B-26 Martin Marauder. Into the construction of this section alone go hundreds of parts manufactured from six basic forms of Reynolds aluminum alloys.

As goes the aircraft industry, so goes *all* industry tomorrow! Aircraft manufacturers today not only receive prefabricated aircraft parts from Reynolds, but in addition use this company's aluminum and aluminum alloy stock in their parts production.

THE GLENN L. MARTIN COMPANY called upon Reynolds to supply six basic shapes for production of parts shown here. Included were bar, tubing, castings, sheet, forgings and extrusions.

Reynolds offers great new alloys...startling new advantages in strength-weight factor

ALMOST OVERNIGHT aluminum has come of age. Today, it's tough, strong, enduring! Actually, new aluminum alloys developed by Reynolds metallurgists, possess unit strengths greater than most structural steels . . . yet section for section, weigh only ⅓ as much. In addition, they are highly resistant to corrosion . . . possess many other qualities of vital interest to manufacturers.

Now the use of aluminum is practicable for entire constructions!

R301 — **Reynolds armor plate alloy—tomorrow's great sheet and plate alloy! Combines a typical tensile strength of 60,000 p.s.i., superior workability, good corrosion-resistance, excellent spot-welding properties. Write for Special Bulletin 50-A. Gives characteristics, properties, other valuable data.**

R303 — **Exceedingly high typical tensile strength. Higher in fact than any aluminum alloy used in the past. Splendid corrosion-resistance. Developed primarily for extrusion and forging stock. Available also in bar, rod, extruded shapes and sheet (bare and clad). Special Bulletin 54-A gives complete information.**

R317 — **Combines free-machining qualities with high strength and excellent heat treatment characteristics. Age-hardens at room temperature after solution heat treatment, thereby eliminates the necessity of costly elevated temperature aging. Good corrosion-resistance. Write for Bulletin 55-A.**

CONSIDER ALUMINUM. Consider the special opportunities—inherent in the new Reynolds aluminum alloys. Consider ease of fabrication . . . thermal and electrical conductivity . . . reflectivity . . . non-magnetic, non-sparking and non-toxic qualities . . . pleasing appearance . . . new low costs. And finally, consider Reynolds nationwide production and service. See catalog in Sweet's . . . or write for Catalog No. 100. Reynolds Metals Company, Aluminum Division, 2524 S Third Street, Louisville, Ky. *Consider aluminum* . . . **CONSULT REYNOLDS!**

REYNOLDS METALS

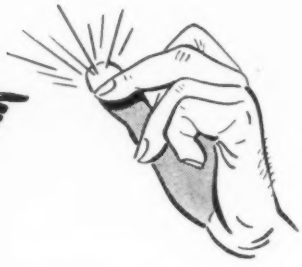
7635-AI-3A

REYNOLDS ALUMINUM

The Great New Source of

INGOT · SHEET · SHAPES · WIRE · ROD · BAR · TUBING · PARTS · FORGINGS · CASTINGS · FOIL · POWDER

Just like this



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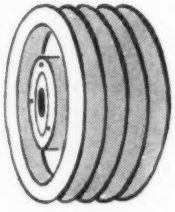
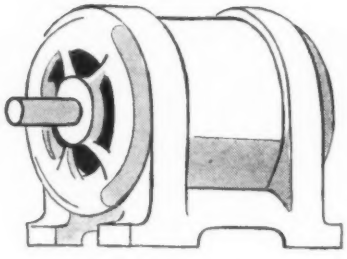
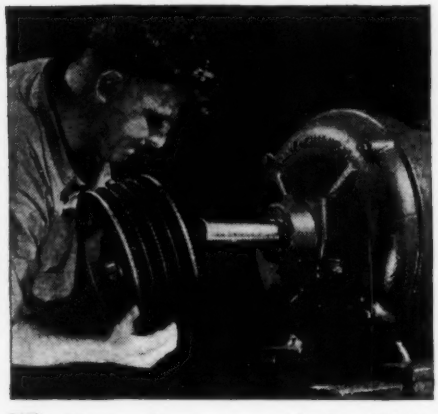


on or off this

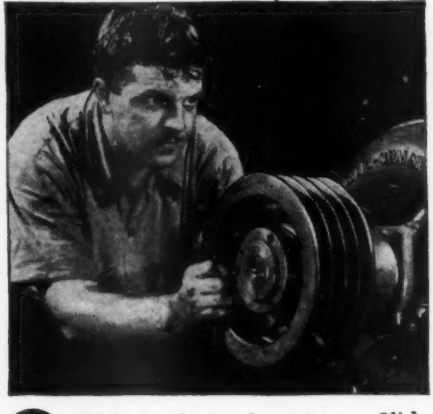


Yes, it's a snap to change sheaves now, when you provide Allis-Chalmers' new "Magic-Grip" — *fastest mounting and demounting sheave on the market.* Saves time and money.

SEE WHY THE NEW "MAGIC-GRIP" MOUNTS FAST, PERFORMS SMOOTHLY



1 Place sheave on shaft. Slides on smoothly because clearance is provided by expanded bushing. There's *no* hammering — *no* forcing! Complete sheave and bushing unit comes intact—ready for quick, easy mounting.

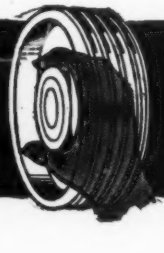


2 Slide to desired position. Sliding easily, sheave can be placed *exactly* according to straight-edge . . . giving you true alignment with resulting smooth performance. A minimum of time is required.

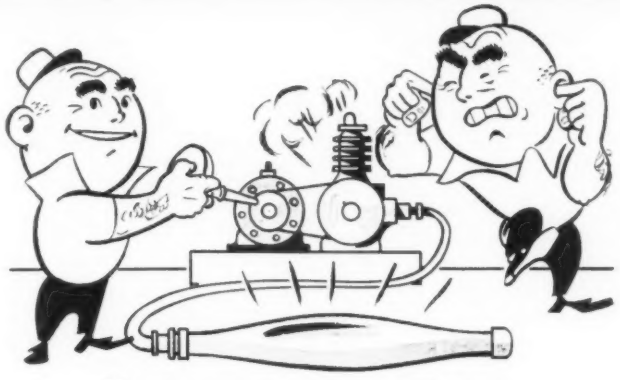
3 Tighten three capscrews — and it's ready to go! Entire sheave is locked securely to shaft and *grips like magic!* No set screws to damage shaft. Send for Bulletin B6310. Allis-Chalmers, Milwaukee 1, Wis.

A 1857

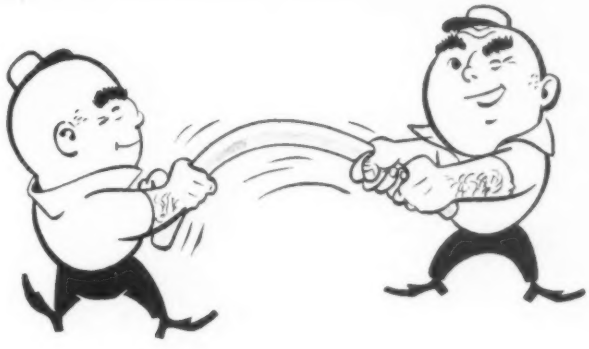
Allis-Chalmers Texrope "MAGIC-GRIP" SHEAVES



HOW BUNDYWELD SCORES
ON ACTUAL STRENGTH TESTS



(1) **ULTIMATE** bursting strength (¼" x .028" annealed) of 12,500 lbs. per square inch.

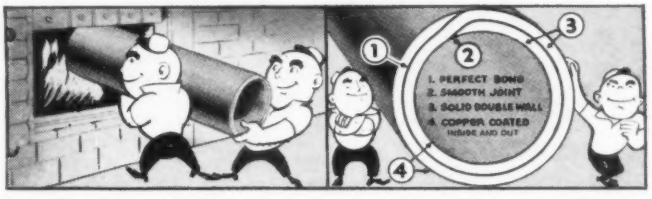


(2) **UNUSUALLY** high fatigue strength . . . especially recommended for use where vibration occurs.

HOW BUNDYWELD IS MADE

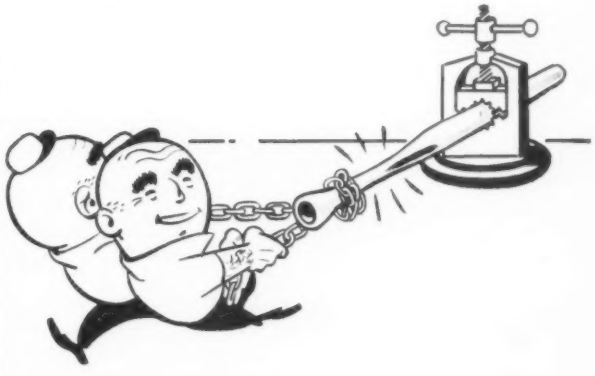
1 Bundyweld Tubing is made by a process entirely different from that used in making other tubing. A single strip of copper-coated S.A.E. 1010 steel is continuously rolled twice laterally...

2 . . into tubular form. Walls of uniform thickness and concentricity are assured by the use of close tolerance cold rolled strip. This double rolled strip passes through a furnace where the . . .

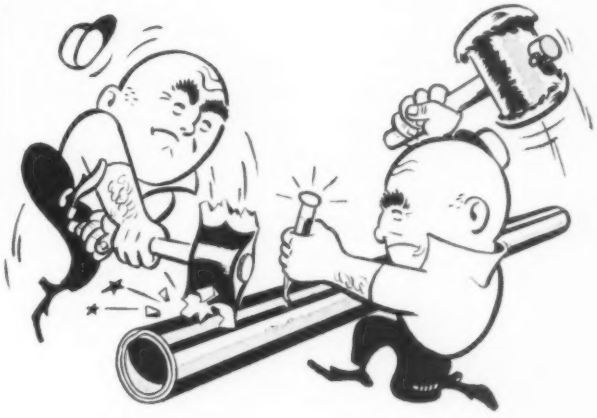


3 . . copper coating fuses and alloys with the double steel walls. After brazing and cooling, it becomes a *solid* double wall steel tube, copper brazed throughout 360° of wall contact . . .

4 . . copper coated inside and out, free from scale and closely held to dimensions. Hard or annealed in standard sizes up to ⅝" O.D. Special sizes cold drawn. Also furnished in Monel.



(3) **ULTIMATE** tensile strength (annealed) 45,000 to 52,000 P.S.I. — yield strength, 30,000 to 36,000 P.S.I. — per cent elongation in 2" — 30% to 40%.



(4) **HARDNESS** - - Rockwell (30T — scale) 43 - 50.

For further information, write Bundy Tubing Co., Detroit 13, Michigan

BUNDY TUBING

ENGINEERED TO YOUR EXPECTATIONS

BUNDY TUBING DISTRIBUTORS AND REPRESENTATIVES:

Pacific Metals Company, Ltd.
3100 19th Street
San Francisco 10, California

Standard Tube Sales Corp.
1 Admiral Avenue
Maspeth, New York City, N. Y.

Lapham-Hickey Company
3333 W. 47th Place
Chicago 32, Illinois

Rutan & Company
112 South 16th Street
Philadelphia 2, Pennsylvania

Eagle Metals Company
3628 East Marginal Way
Seattle 4, Washington

design with magnesium

FABRICATED IN ALL USUAL FORMS

1—SAND CASTINGS

2—PERMANENT MOLD CASTINGS

3—DIE CASTINGS

4—ROLLED SHEET, PLATE, AND STRIP

5—EXTRUSIONS: ROD, BAR, TUBING, AND SPECIAL SHAPES

6—FORGING: PRESS AND HAMMER METHODS

7—FORMED BY BENDING, DRAWING, PRESSING, AND SPINNING

JOINED BY ALL COMMON METHODS

RIVETING

GAS WELDING

ARC WELDING

SPOT WELDING

FLASH WELDING

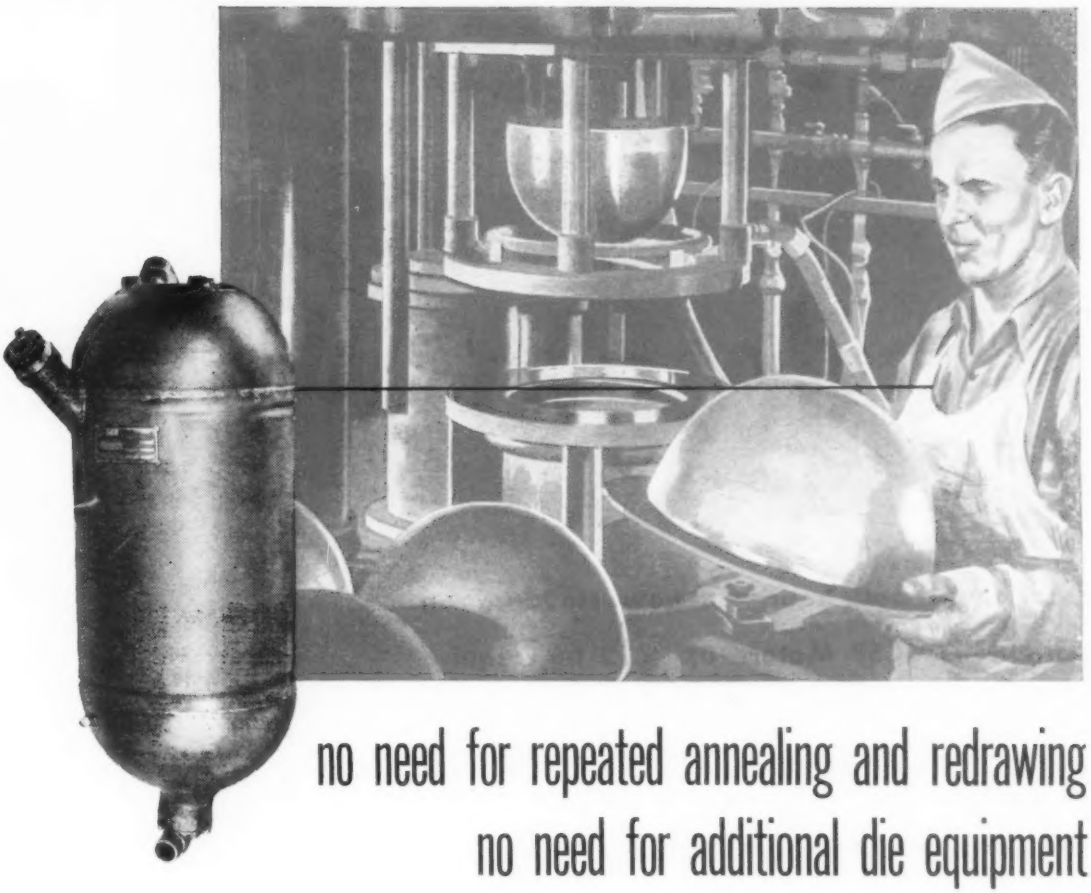
DESIGN NOTES ON FORMING (No. 7).

Methods employed for forming magnesium compare with those used for other metals. Magnesium, however, is usually formed at elevated temperatures—offering several advantages over cold working. Magnesium parts are usually formed in a single operation—there is no need for repeated annealing and redrawing. Thus not only is time cut in making the part, but the need for additional die equipment for drawn parts is eliminated. Hot forming also permits the reduction of allowances for spring-back. When forming at 600° F. no spring-back allowance is necessary. At lower temperatures, allowances depend upon the type of alloy, thickness of material, radius of bend and forming temperature.

Magnesium Alloy sheet can be blanked, punched and sheared much the same as other metals. Complete data on these and other operations are available to you.

DOW'S LONG EXPERIENCE WITH MAGNESIUM IS AVAILABLE TO YOU—***CONSULT WITH DOW***

—deep drawn parts in one operation



no need for repeated annealing and redrawing
no need for additional die equipment

Here's another of those magnesium fabrication advantages that helps make this lightest structural metal so important to manufacturers: You can produce deep drawn parts in a single operation, saving both time and equipment.

The aircraft industry, among others, is thoroughly familiar with this technique. Plane manufacturers are putting out engine oil tanks, nose spinners, wheel dust covers, hub caps—any number of similar parts—by deep drawing magnesium in one operation.

With this hot forming method it's common to draw cylindrical cups to a depth of 1.5 times their diameter in a single draw—with a reduction of 60 to 65 per cent. To get similar results in cold drawing steel, it would be necessary to draw to a larger diameter, anneal, and redraw several times.

When you design deep drawn parts, design with magnesium—and do the job *in one operation!*

DRAW ON 29 YEARS' EXPERIENCE

Your first step toward applying these important advantages in your own shop should be to get in touch with Dow. During its 29 years' experience in the magnesium field, The Dow Chemical Company has compiled a wealth of engineering data now yours to draw upon. Just contact the nearest Dow office.

MAGNESIUM

THE METAL OF MOTION

MAGNESIUM DIVISION, THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington • Cleveland • Detroit • St. Louis • Chicago • Houston • San Francisco • Los Angeles • Seattle

Install in 1945 do not lubricate

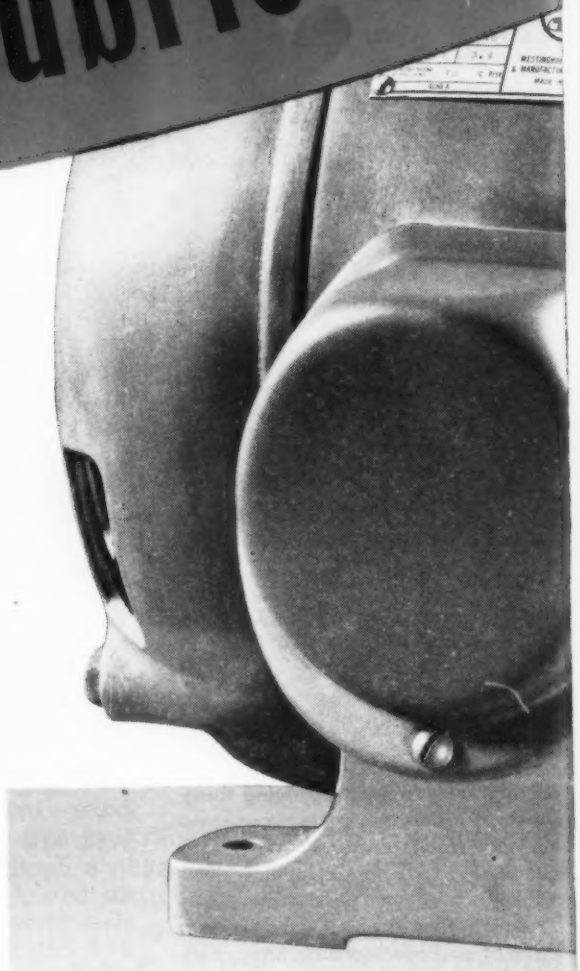
Prelubricated ball bearings, now standard on Westinghouse CSP Motors up to 3 hp, require lubrication only after five years' or more service

Westinghouse Type CSP Motors, 3 hp and below, bought in 1945, will not require lubrication before 1950. Think of it! Five years of operation : : : 24 hours a day : : : with no attention whatever to lubrication. In 1950, inspect bearings. If greasing is needed—a simple disassembly job—and the motor is all set to run until 1955.

These prelubricated sealed ball bearings have been thoroughly field-tested in textile mills and in built-in machine tool installations. Early installations are still running on the original grease after seven years' service.

CSP motors may be mounted in any position, including the vertical. Wherever Class A insulation is applied, at least five years of operation without greasing may be expected. Applications in higher than normal ambient temperatures may require modified design.

For complete information, ask for DB-3100-CSP at your Westinghouse office. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21326



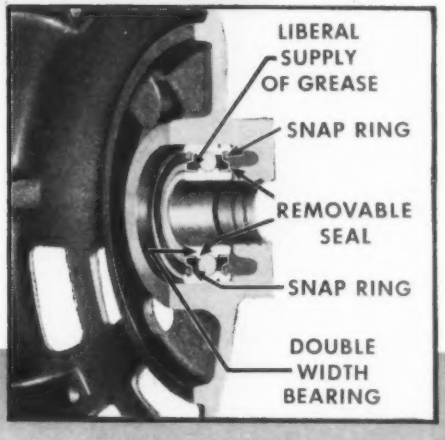
ONLY WESTINGHOUSE CSP MOTORS OFFER ALL THESE ADVANTAGES

- **PRELUBRICATED SEALED BALL BEARINGS reduce lubrication maintenance . . . assure longer grease life.**
- **IMPROVED TUFFERNELL INSULATION.**
- **DYNAMICALLY-BALANCED ROTOR.**
- **DIE-CAST ROTOR with oversize fan.**
- **LIBERAL THROUGH-VENTILATION—air enters front, leaves at drive-end of motor.**

before 1950!

This label appears on the end bracket of every CSP motor up to frame 225. It is your assurance of smooth operation, long bearing life, and low maintenance. It also means:

- No overgreasing.
- No grease seepage into windings.
- No unreplaced plugs.
- No costly lubricating schedules.
- No grease contamination.
- No "skipped" bearings while greasing.



HOW IT WORKS

High-grade, long-life grease, specifically designed for these bearings, is packed into the bearing assembly by the bearing manufacturer. This original grease is good for at least five years of normal service. Double-width, single-row construction permits a more liberal grease supply and better sealing than the single-width design. Two seal discs, locked into the outer race by snap rings, fit closely over the inner race to form a revolving seal.

When motor is disassembled for other reasons, this construction keeps dirt out of bearings just as effectively as the cartridge bearings now in common use.

Westinghouse

PLANTS IN 25 CITIES... OFFICES EVERYWHERE

TYPE CSP MOTORS

OCTOBER 2, 1941

WE RENEW OUR PLEDGE

Two years ago, at the beginning of the present war with its uncertainties and threats to the future of all industry, this Company publicly pledged itself not to increase its selling prices.

On this, the second anniversary, we again publicly renew that pledge.

During the last two years we have not only kept the pledge previously made, but *we have actually reduced our selling prices by more than* 6% because of more efficient operation made possible by the marvelous cooperation and ability of our organization. This was accomplished in the face of rising labor and material costs, both of which have been increased by considerable amounts.

It is our belief that the only hope for the continuance of the present industrial system now threatened from within and without is in its ability to give more and more to the consumer for less and less of his dollar. This is the strength of American individual initiative. This is the hope of our country's future. If American industry can accomplish this universally, we need not fear dictators either at home or abroad.

THE LINCOLN ELECTRIC COMPANY

Cleveland, Ohio
October 2, 1941

J. F. Lincoln
President

STATEMENT OF POLICY

The world is entering a crisis, the result of which no one can foresee. Other wars have brought inflation, followed by unemployment and depression after peace was achieved. America's experience in the World War illustrates this fact.

Much of this post-war trouble would have been eliminated by a more foresighted price policy on the part of manufacturers and distributors. Price inflation by the seller when he had a dominant position resulted inevitably in reaction with deflation, depression and suffering. Many of those price increases were not warranted.

Before such an inflationary cycle of prices is again started, we publicly pledge ourselves, as far as possible, to maintain present prices.

Further, if the materials we buy are increased in price, or the cost of labor is increased, then we pledge ourselves to raise selling prices no more than the bare increase in cost of raw materials and labor going into our products.

Further, we pledge ourselves to pass on to our customers the reduction in cost made possible by better manufacturing methods, wider distribution and technical advances in production.

THE LINCOLN ELECTRIC COMPANY

Cleveland, Ohio
October 2, 1939

J. F. Lincoln
President

OCTOBER 2, 1939

★ ★ OUR PLEDGE MAINTAINED ★ ★

On October 2, 1939, we announced the policy of "no increase in selling prices". A progress report made October 2, 1941, showed we actually had reduced prices by more than 6% during the period 1939 to 1941.

We have adhered to this policy of price reduction throughout the war years. Despite general increases in the costs of labor, materials and distribution . . . and despite governmental regulations . . . we have been able to maintain or reduce our prices throughout the entire period from 1939 to date.

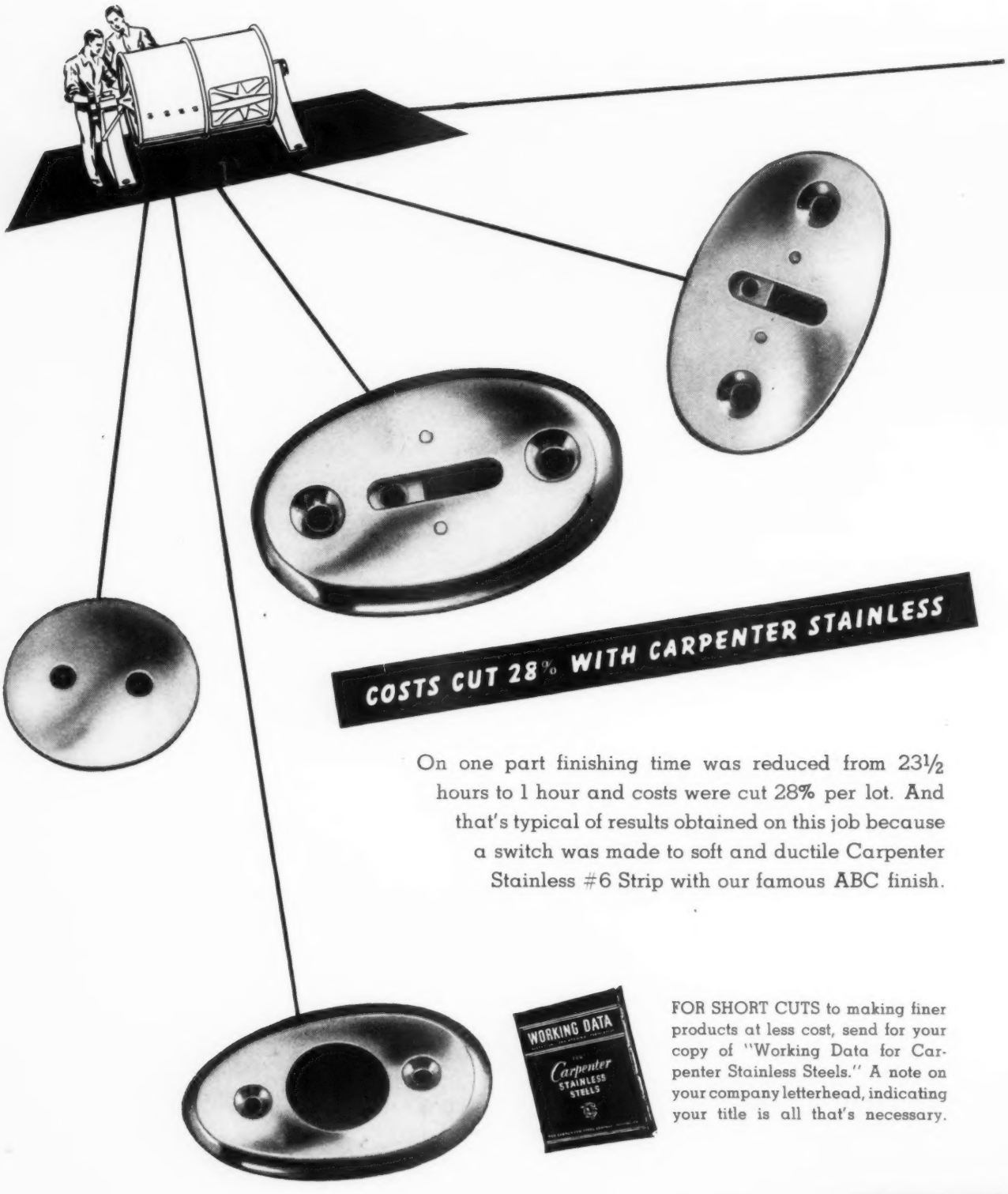
This has been made possible by our incentive system . . . a method which, if it had been applied throughout industry, would have doubled America's output of war goods for a quicker Victory and would have cut the cost of the war by 50%.

America's future depends largely upon her *efficiency of production.* Our proved incentive system has in it the seeds of a satisfactory answer to the difficulties of this nature in industry.

THE LINCOLN ELECTRIC COMPANY

Cleveland 1, Ohio
May 7, 1945
Victory in Europe

J. F. Lincoln
President



COSTS CUT 28% WITH CARPENTER STAINLESS

On one part finishing time was reduced from 23½ hours to 1 hour and costs were cut 28% per lot. And that's typical of results obtained on this job because a switch was made to soft and ductile Carpenter Stainless #6 Strip with our famous ABC finish.

FOR SHORT CUTS to making finer products at less cost, send for your copy of "Working Data for Carpenter Stainless Steels." A note on your company letterhead, indicating your title is all that's necessary.

THE CARPENTER STEEL COMPANY, 117 W. BERN ST., READING, PA.

more than corrosion resistance

YOU GET CORROSION RESISTANCE *Plus* LOWER COSTS ON FINISHED PARTS

...with Carpenter Stainless

By starting with a stainless strip which has a bright, smooth surface, free from marks or scratches, you can eliminate many final polishing operations and substantially cut finishing costs. Read how one manufacturer saved up to 28% on one job, by switching from a nickel-plated non-ferrous metal to Carpenter Stainless Strip.

The plates on this truss are made from Carpenter Stainless #6 (Type 430) Strip supplied with our standard ABC finish. All that was necessary to secure a bright and gleaming surface was to blank and tumble these parts. Previously made from nickel plated non-ferrous metal they had to be blanked, polished, plated, final polished and buffed. Now instead of finishing each piece separately, job lots can be tumbled at one time, thus affording substantial savings in time and expense.

By using Carpenter Stainless Strip with a bright finish, you can reduce your finishing operations and cut production costs. In your planning of new or redesigned products investigate Carpenter Stainless Steels. Your nearby Carpenter representative can help you select the stainless and finish that will do the job best. Call him in today.

GIVE YOUR PRODUCTS THESE ADVANTAGES WITH CARPENTER STAINLESS

- Strength and Rigidity
- Heat Resistance
- Weight Saving
- Freedom from Rust
- No Plating to Peel
- Ease of Assembly
- Longer Product Life
- Sales Appeal

Carpenter STAINLESS STEELS

BRANCHES AT
Chicago, Cincinnati, Cleveland, Detroit, Hartford, Indianapolis, New York, Philadelphia, St. Louis

Aluminum

MEETS THESE REQUIREMENTS for electronic equipment:

Light weight with sturdiness is necessary, whether the device is carried in a plane or by ground troops.

Corrosion resistance provided by Alcoa Aluminum Alloys assures greater dependability under battle conditions.

Electrical properties of aluminum—high conductivity, non-magnetic, nonsparking—suit it for electronic purposes.

Electroplating

IMPROVES ALUMINUM'S NATURAL ADVANTAGES:

Silver plating, for example, gives higher surface conductivity for high frequency currents employed electronically.

Soldered assemblies are possible where surfaces to be joined have been plated.

Successful plating on a production basis is an accomplished fact. "Careful control, knowing how, and strict adherence to formulae", are the rules laid down.

Perhaps you can help

Additional facilities are needed to increase the production on plating operations. Agencies in charge of procurement say they will welcome the assistance of other companies in boosting output of wartime electronic equipment.

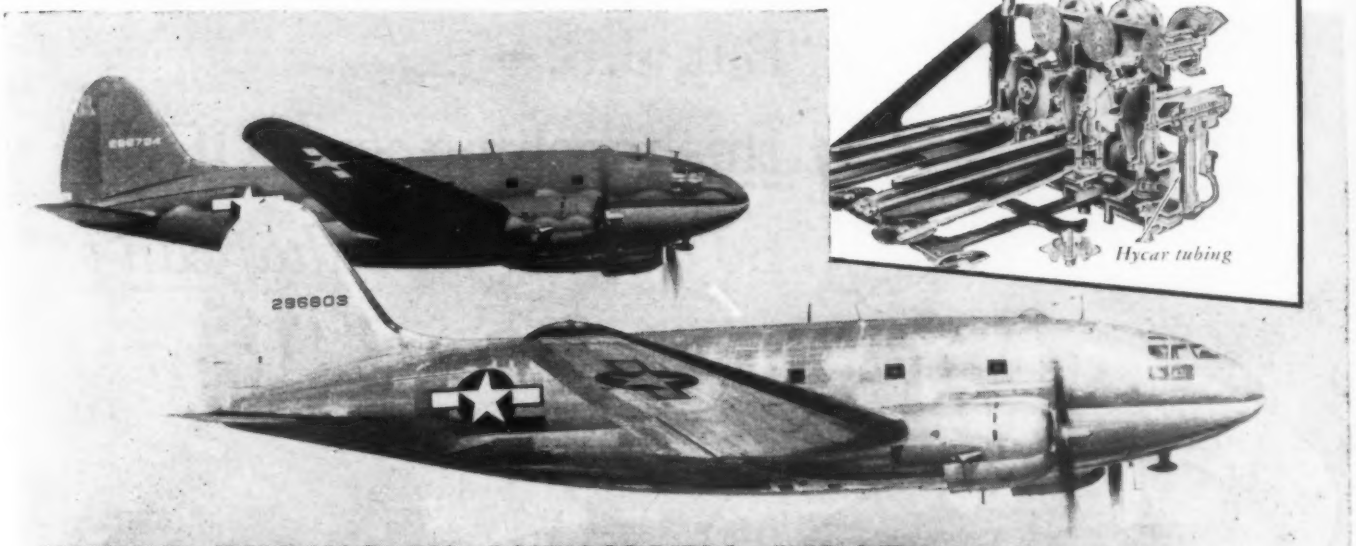
Alcoa offers you basic information on plating aluminum which will let you adapt the processes to your plant. If interested, write ALUMINUM COMPANY OF AMERICA, 2193 Gulf Building, Pittsburgh 19, Pa.

ALCOA

ALCOA FIRST IN ALUMINUM

★ **One of many important industrial applications for HYCAR**

Hycar tubing



HYCAR TUBING IN AUTOMATIC PILOT HELPS CURTISS COMMANDO OVER THE *Hump*

Hycar Parts by Ohio Rubber Co.

DESIGN engineers at Jack & Heintz wanted to get away from the use of copper for a drain tube in their famous automatic pilot. With the right resilient material they could avoid the use of fittings which require more manpower for both manufacture and assembly of the complicated units. But the hydraulic fluid used, an asphaltic base oil, caused natural rubber to disintegrate, and most synthetic rubbers to swell out of shape quickly. Any failure of the tubing in the automatic pilot could easily cause the loss of a plane like the huge Curtiss Commando that is hauling men and important supplies to every corner of the world.

Then Hycar was tested and proved that its superb oil resistance provided the answer—no deterioration, minimum swelling or shrinkage. Its excellent permanent set characteristics did away with the need for clamps to hold the tubing in place. Hycar's ability to remain practically unchanged over a wide range of temperatures—from 70 degrees below zero to 185 above, meant further that the tubing would be failure proof under all conditions. Today, two small sections of tubing made from Hycar go into every Jack & Heintz automatic pilot to help our fliers get there and back safely.

Other important properties of Hycar synthetic rubbers are shown in the box at the right. These properties may be had in *selected combinations* to meet known service conditions. Ask for parts made of Hycar. Test them in your own applications—difficult or routine. Learn for yourself that it's wise to use Hycar for long-time dependable performance. *Hycar Chemical Company, Akron 8, O.*

CHECK THESE SUPERIOR FEATURES OF HYCAR

1. *EXTREME OIL RESISTANCE—insuring dimensional stability of parts.*
2. *HIGH TEMPERATURE RESISTANCE—up to 250° F. dry heat; up to 300° F. hot oil.*
3. *ABRASION RESISTANCE—50% greater than natural rubber.*
4. *MINIMUM COLD FLOW—even at elevated temperatures.*
5. *LOW TEMPERATURE FLEXIBILITY—down to —65° F.*
6. *LIGHT WEIGHT—15% to 25% lighter than many other synthetic rubbers.*
7. *AGE RESISTANCE—exceptionally resistant to checking or cracking from oxidation.*
8. *HARDNESS RANGE—compounds can be varied from extremely soft to bone hard.*
9. *NON-ADHERENT TO METAL—compounds will not adhere to metals even after prolonged contact under pressure. (Metal adhesions can be readily obtained when desired.)*

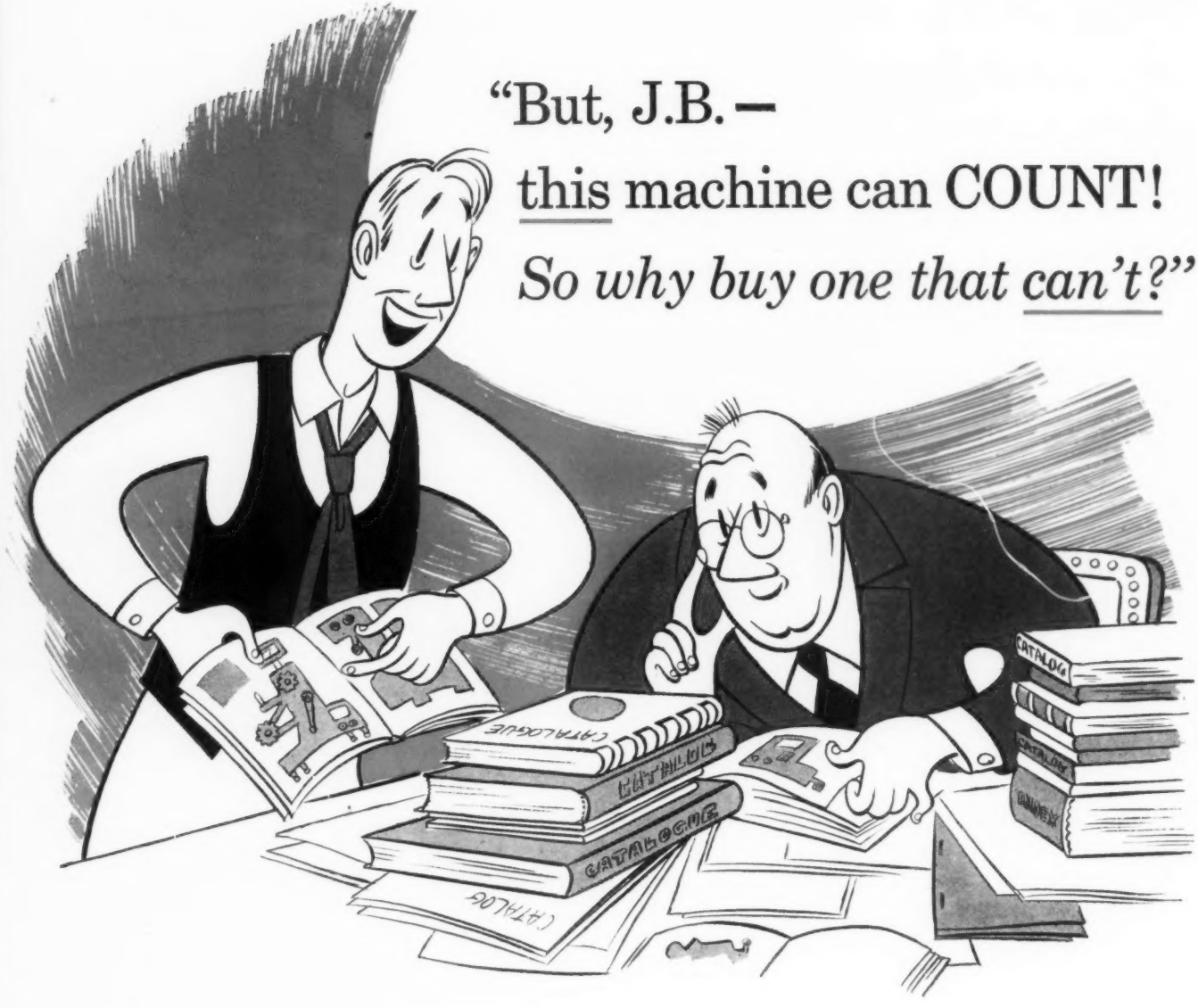
Hycar

Reg. U. S. Pat. Off.

LARGEST PRIVATE PRODUCER OF BUTADIENE TYPE

Synthetic Rubbers

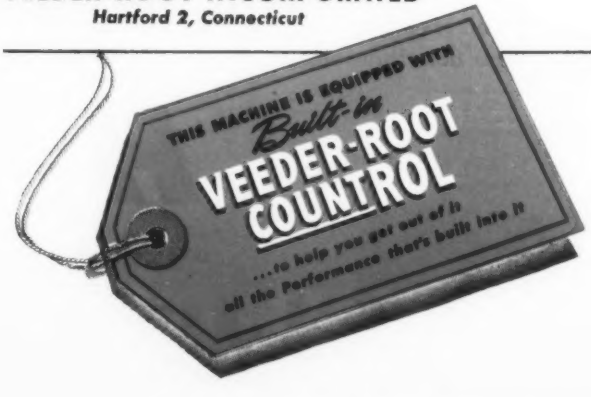
"But, J.B.—
this machine can COUNT!
So why buy one that can't?"



Other things being equal, products equipped with built-in Veeder-Root *Count*rol have a definite edge in customer-acceptance. For this *extra service* . . . of giving an up-to-the-minute account of its own performance . . . is a service that has many different advantages in a customer's eyes. It gives him the advantage of being able to see whether he is getting out of your machine all the performance you built into it. It gives him the advantage of being able to avoid errors, arguments, delays, shortages and late deliveries. It enables him to anticipate maintenance . . . to *Count*rol production more closely.

All these advantages of Veeder-Root *Count*rol are advantages *you* can sell as features of your machine. For Veeder-Root Devices can be readily designed and built into your machines without basic design changes. There are Veeder-Root Devices to count any unit of motion or performance, electrically or mechanically. And you can have Veeder-Root engineers show you, *now*, in how many ways you can profit by attaching this tag to your machines.

VEEDER-ROOT INCORPORATED
Hartford 2, Connecticut



WESTINGHOUSE CREATED THE Ignitron

...it revolutionized welding and is now finding new fields of usefulness

The smooth, silent operation of resistance welding equipment is made possible by the ignitron tube—originated by Westinghouse. Ignitron tubes have broadened the field of welding to include projection welding. They have lowered costs, and increased speed and efficiency in all types of resistance welding operations. Westinghouse makes a complete line of ignitrons, the smallest of which is the WL-681/686 shown here.

But welding is only one field where ignitrons can be used. They are useful in timing operations requiring high peak currents for short durations, as X-Ray timers. They are useful in the field of motor speed control to govern the speed of medium horsepower motors. They may also be used in the field of frequency conversion and inversion.

In the WL-681/686, you have a small, light, compact tool of many applications and many adaptations of present applications. Write Lamp Division, Westinghouse Electric Corporation, Bloomfield, New Jersey.

IGNITRON WL-681/686
for welding service

Maximum welder demand	300 kva
Maximum average current per tube	22.4 amp
Maximum RMS supply voltage	600 volts
Length+lead	9.75+7 inches
Diameter	2.13 inches

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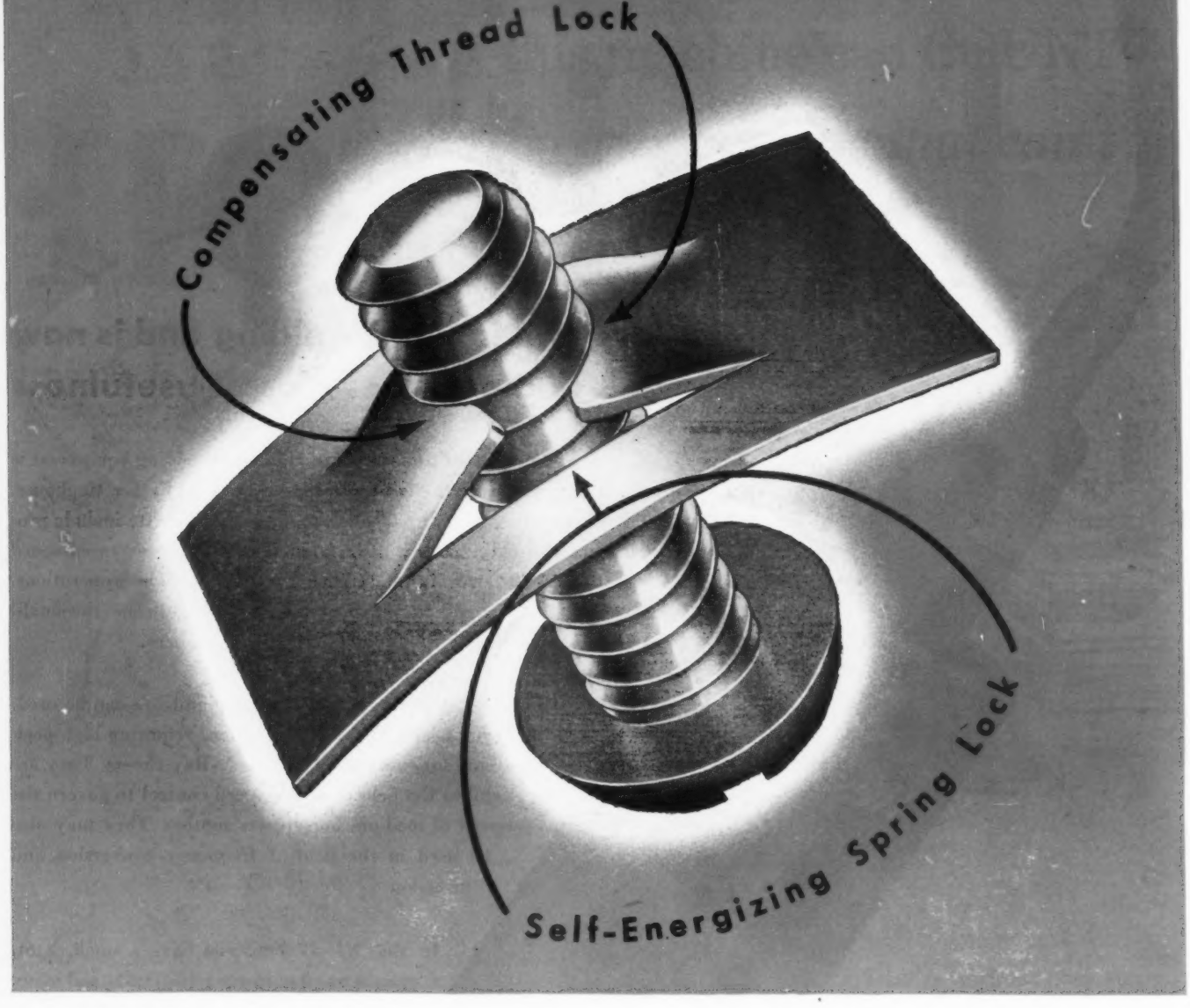
Westinghouse

PLANTS IN 25 CITIES OFFICES EVERYWHERE

Electronic Tubes at Work

NOTHING LOCKS LIKE A SPEED NUT



SPEED NUTS are the only fastening devices that provide a **COMPENSATING** thread lock and a **SELF-ENERGIZING** spring lock. **TWO** distinct forces are exerted on the screw, as the **SPEED NUT** is tightened.

First, a compensating thread lock, the two arched prongs moving inward to engage and lock against the root of the screw thread. These free-acting prongs compensate for tolerance variations, and function perfectly on oversize or undersize screw or bolt threads.

Second, a self-energizing spring lock, created by the compression of the arch in both the prongs and base. The combined forces of the thread lock and spring lock definitely eliminate vibration loosening.

SPEED NUTS, proven in pre-war commercial industry and now boosting the production of airplanes, are ready to assist you in the assembly of post-war metal, vitreous enamel, plastic or wood products. Literature is available on over 3000 shapes and sizes, for standard or special assemblies.

TINNERMAN PRODUCTS INC.
2041 Fulton Road — Cleveland 13, Ohio

Speed Nuts
PATENTED
* Trade Mark Reg. U. S. Pat. Off.

FASTEST THING IN FASTENINGS

IT'S TIME TO GIVE YOUR POST-WAR PRODUCTS THEIR DRESS REHEARSAL

Be sure to add Eye Appeal by using the right kind of Industrial Finish!

Your product may incorporate the best in engineering design and construction, but unless it also has eye appeal, it won't receive top billing in the post-war competitive market.

Since it's time for a dress rehearsal, determine now just what requirements are needed for the finish on your product. Beauty, durability, color, resistance to corrosion—these are some of the important factors that will determine the proper coating. Line them up and then let us help you select the proper M&W finish to meet these requirements.

"Eye Appeal Means BUY Appeal"

WE ARE HEADQUARTERS FOR SOLVING INDUSTRIAL FINISH PROBLEMS!

A sizable portion of the Maas and Waldstein Research Laboratories is devoted to solving industrial finishing problems.

You are invited to avail yourself of these services. Write us today.

MAAS & WALDSTEIN COMPANY, NEWARK 4, N. J.

PRODUCERS OF LACQUERS, ENAMELS, SYNTHETICS AND SPECIALTY FINISHES FOR ALL PURPOSES

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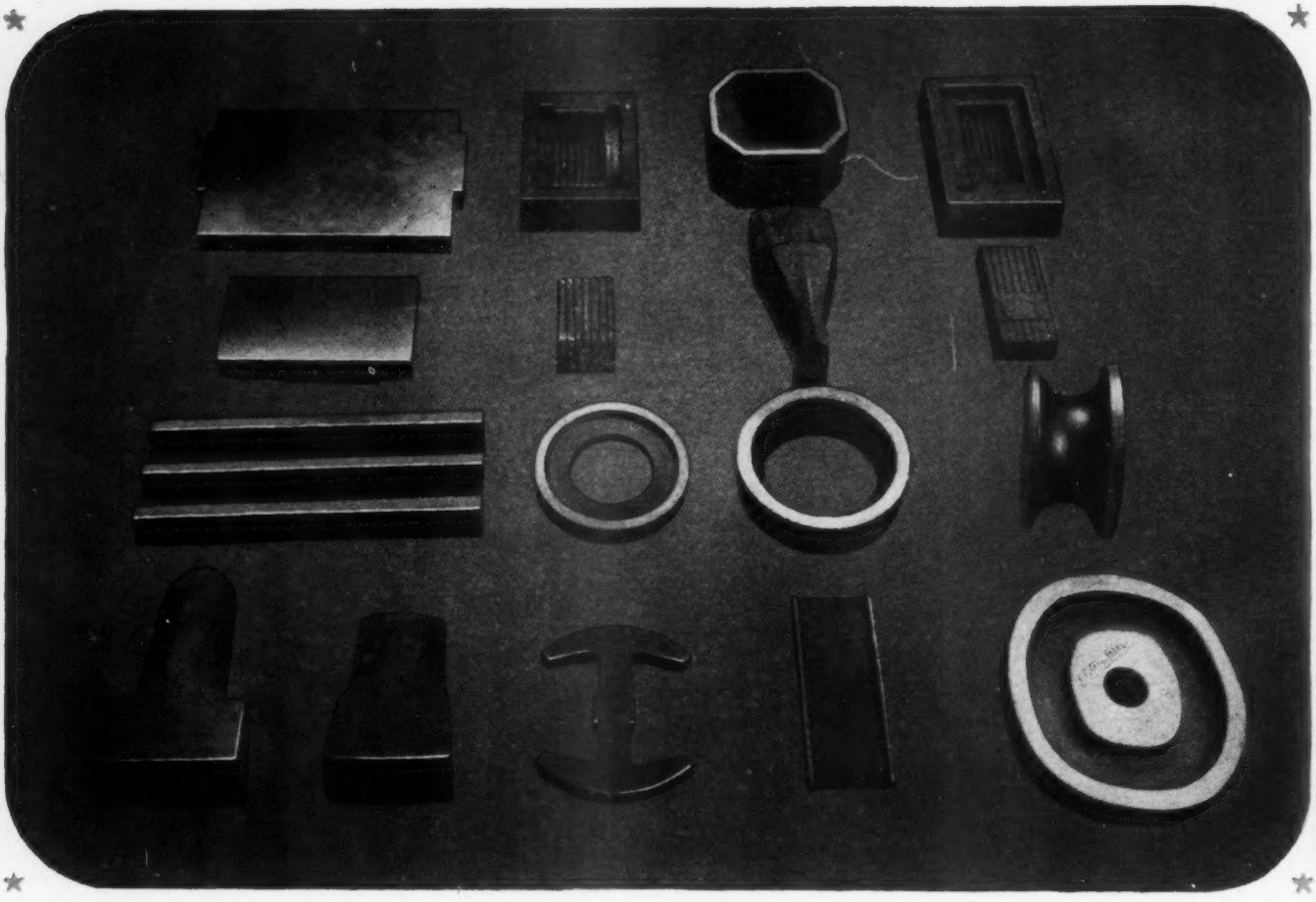

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It contains details of FCC Tool Steels Cast To Shape and of other important Forging and Casting Division specialties that may offer you money-saving production ideas. Get your copy—write for it today.

Address Dept. PE-34

WHEN it's dies you're making—small or large—or various other forming tools or gages or certain fast-wearing parts of machines, FCC Tool Steel Cast To Shape can really save you money.

Very intricate shapes can now be cast in one piece within an eighth-inch of finished size. This means that you pay for less steel to begin with, and reduce machining time substantially.

Air Hardening, Oil Hardening and special Hot Work Tool Steels of various grades—each a thoroughly dependable performer in its class—are available in this modern, economical form.

Prompt delivery under CMP.

Allegheny Ludlum
STEEL CORPORATION
Forging and Casting Division
DETROIT 20, MICHIGAN

How Allis-Chalmers Engineering Discovers New Ways to Build Better Motors for You.

WANTED: D-C Motors to Dive for Navy!

BUILD SUBMERSIBLE MOTORS to run 25 feet under water — and build 'em to run that way 90 days at a stretch! That's the tough assignment Navy engineers turned over to Allis-Chalmers.

Those motors had to: 1) withstand sea pressure; 2) stay waterproof; 3) be light in weight.

No. 1 problem was . . . *how to build water-tight casings.* A-C engineers experimented, found the solution in fabricated steel.

Quickly, individual casing parts were built. Subsequent hydrostatic tests applied to them showed molecular arrangement and carbon content of steel to be ok. Result —only a heavy weld between fabricated parts was needed to assure water-tightness!

Now the going was easier. For adequate surface seal, field yokes of one-inch rolled steel were used. End housings were reinforced. Exposed adjustments were made leakproof. Then . . . minor changes in insulation, at other points, and the problem was solved.

* * *

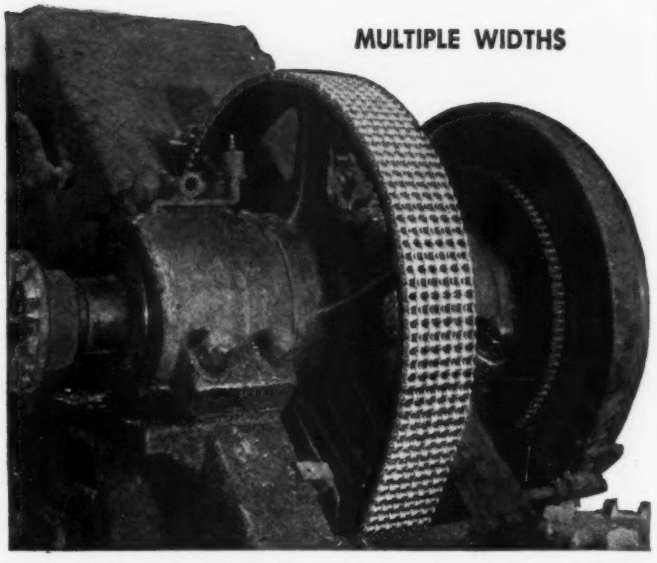
"What's all this got to do with *my* problems?" you may ask. Just this . . . Everytime A-C tackles the job of building special motors for extra-tough war applications, like this one, it also discovers important new ways to build better *standard* motors for you!

That's why you hear it said so often, *"You can depend on Allis-Chalmers Motors!"* ALLIS-CHALMERS, MILWAUKEE, WIS.

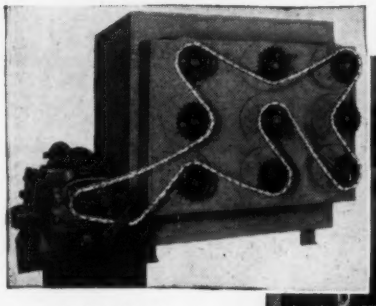
A 1889

You Can Depend on ALLIS-CHALMERS Motors

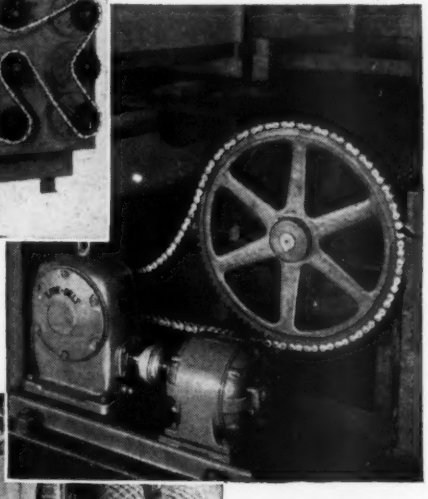
WHAT *Can't* YOU DO *with* LINK-BELT *Silverlink* ROLLER CHAIN?



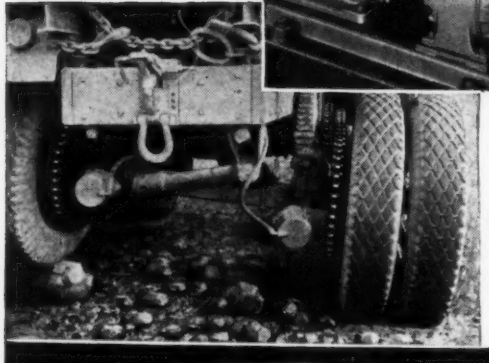
MULTIPLE WIDTHS



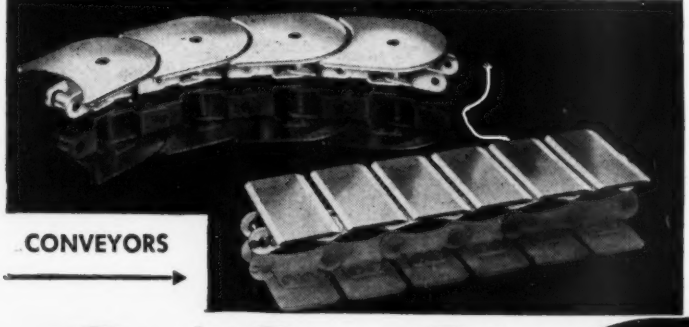
MULTIPLE SHAFTS



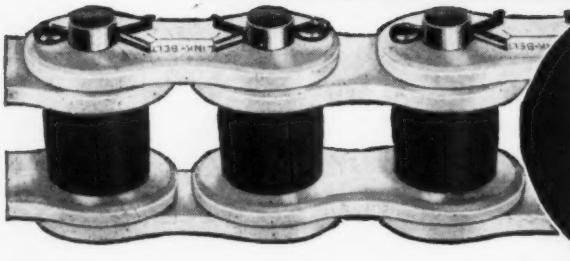
POSITIVE RATIO



TWIST TYPE FOR MOBILE EQUIPMENT



CONVEYORS



MODERN DESIGN Continually Utilizes its Basic Advantages

● Designers and manufacturers seeking new versatility and new efficiency in their products rely more and more on the numerous advantages of Silverlink Roller Chain.

Positive transmission of power means perfect timing and coordination of machine operations. Shafts in any number, in any arrangement, can be given either direction of rotation, on long or short centers. While slip or creep is impossible, resilience of chain absorbs heavy shock loads, thereby protecting motor and driven machine.

Depend on Link-Belt Silverlink Roller Chain for efficiency and long service in power transmission and conveying. Write for Engineering Data Book 1957.

LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices, Factory Branch Stores and Distributors in principal cities.

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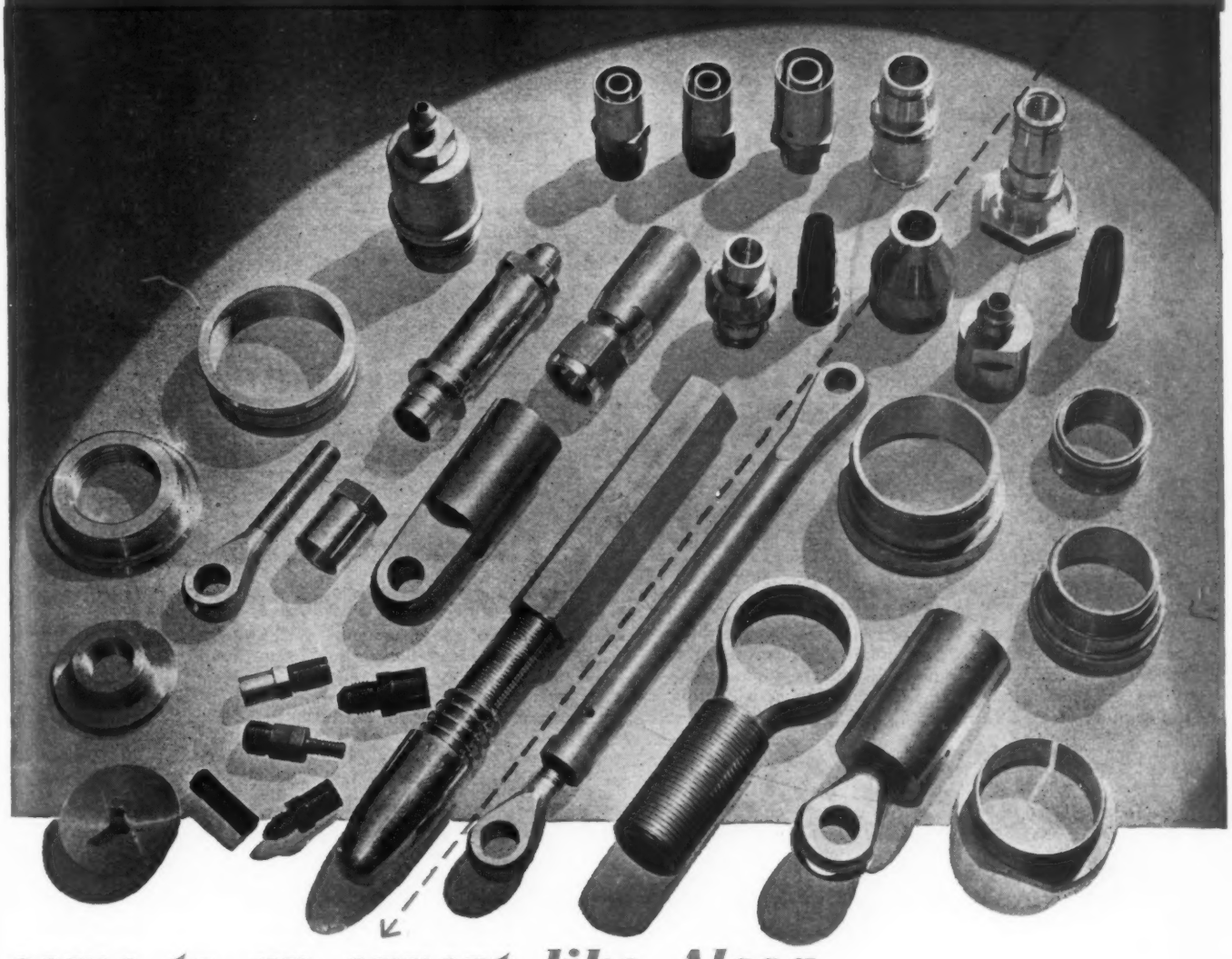
LINK-BELT *Silverlink* **ROLLER CHAINS**

When the part is "unusual"....



come to an expert like Alcoa

They're war workers, these Alcoa Aluminum screw machine products, performing vital tasks in Uncle Sam's fighting equipment. Many of them are unusual. Tolerances are usually exacting, quantities high, calling for a combination of high speed production and near toolroom accuracy.

For years, Alcoa has operated a screw machine division. Appetites have been whetted by these unusual assignments, as machines hummed along on standard production. We've aided Aluminum Research Laboratories in developing finer, faster machining alloys.

Whether you're in the market for screw machine products or stock, we'll welcome the opportunity to quote on your requirements. Write ALUMINUM COMPANY OF AMERICA, 2193 Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA FIRST IN **ALUMINUM**

ALCOA ALUMINUM

SHUTS OUT SLIP-UPS!

Assembling baby furniture was mighty slow work with slotted screws, one manufacturer found. Too many scratches to refinish – scratches caused by driver skids. So to pick up production he switched to Phillips Screws . . .

FRIENDLY TO PROFITS!

. . . out went burred heads and driver skids and slant driven screws. Out went slow-as-molasses hand driving. In came power driving – and with it, savings in time and materials that sliced a big chunk off assembly costs.

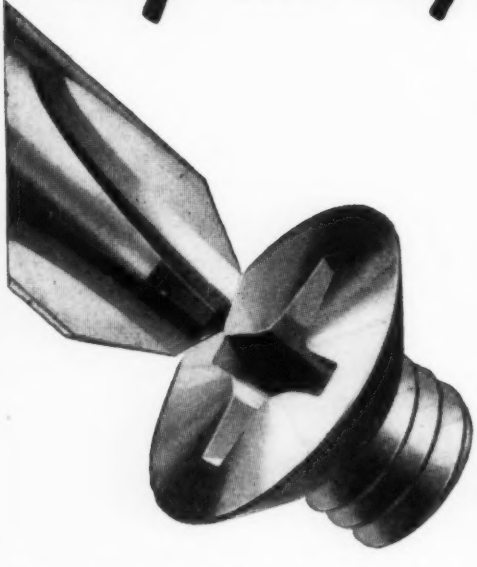
LONG ON SAFETY!

By making it stronger and more rigid, and by banishing dangerous burrs, Phillips Screws made this furniture safer for the kids. And your designers will find they do the same things for your product – whether it's tiny as a hearing aid or hefty as a harvester!

TOUGH ON COMPETITION!

Because of the ornamental design of the recess, Phillips Recessed Head Screws impart a "quality look" to any product. They give you a burr-free, blemish-free job that tells prospects you're on *your* toes – and warns competitors to watch out for *theirs!*

It's Phillips — the engineered recess!



In the Phillips Recess, mechanical principles are so correctly applied that every angle, plane, and dimension contributes fully to screw-driving efficiency.

. . . It's the exact pitch of the angles that eliminates driver skids.

. . . It's the engineered design of the 16 planes that makes it easy to apply full turning power – without reaming.

. . . It's the "just-right" depth of recess that enables Phillips Screw Heads to take heaviest driving pressures.

With such precise engineering, is it any wonder that Phillips Screws speed driving as much as 50% – cut costs correspondingly?

To give workers a chance to do their best, give them faster, easier-driving Phillips Recessed Head Screws. Plan Phillips Screws into your product now.

PHILLIPS *Recessed Head* SCREWS

WOOD SCREWS • MACHINE SCREWS • SELF-TAPPING SCREWS • STOVE BOLTS

Made in all sizes, types and head styles

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General Screw Mfg. Co., Chicago, Ill.
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The Lamson & Sessions Co., Cleveland, Ohio
Manufacturers Screw Products, Chicago, Ill.
Milford Rivet and Machine Co., Milford, Conn.
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New England Screw Co., Keene, N. H.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Manufacturing Co., Chicago, Ill.
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"HIGH-PRESSURE DIE CASTING"

A Design Guide for Engineers by

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This engineering text records for the first time the essential elements of design affecting the use and production of the highest quality die castings. No other book on this subject, so vital to modern production, has approached the subject from the standpoint of informing users and designers of metal good as to those elements of design that control the successful application of die castings to any product. There are no generalities in the text, every page is pertinent and vital information to material, process, design and production engineers, production personnel, inspectors and executives.

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"Red" Harvill is the pioneer of high quality die castings made from aluminum, magnesium and copper, and is one of few men in this country qualified to deal with all phases of die casting design, production and use. By instituting this book, "Red" Harvill makes available... for the first time.... important engineering information never before published. No engineering, metallurgical or production library can be complete without this new treatise.

- ★ **Gives you the correct answers to these questions:**

What Metals can be used in die casting?

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How much draft on all surfaces of a die casting is required?

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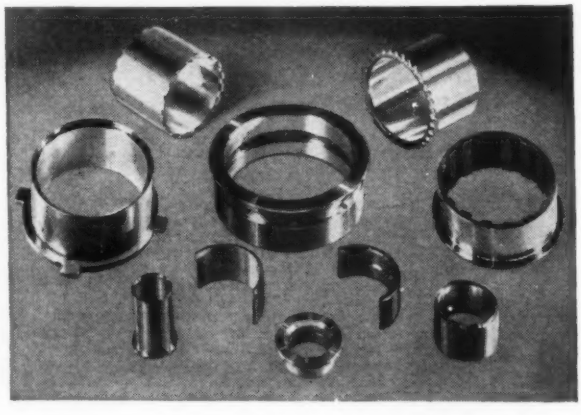
2/10,000 of an Inch Can Make a Big Difference in Your Post-War Product

IT'S an important matter that Mallory silver bearings are made to tolerances as low as 2/10,000 of an inch. They are used in the fastest military planes today: planes where pressures and stresses are high, where uniformity and dependability are critical essentials.

This same precision can mean much to your post-war product. Especially where speeds or loads are great!

By use of an electrolytic process that deposits silver on base metal backings, these bearings can now be made in enormous quantities—*quickly*, too! Costs have been reduced by various techniques so that prices compare favorably with other type bearings. In addition, Mallory manufactures precision bearings of other metals—all to the same accurate tolerances.

Mallory research, in fact, is constantly devoted to the development of new bearing materials and improved production techniques. This accumulated experience is yours for the asking. If you manufacture any of the equipment listed below, our engineers are in a special position to help you.



P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

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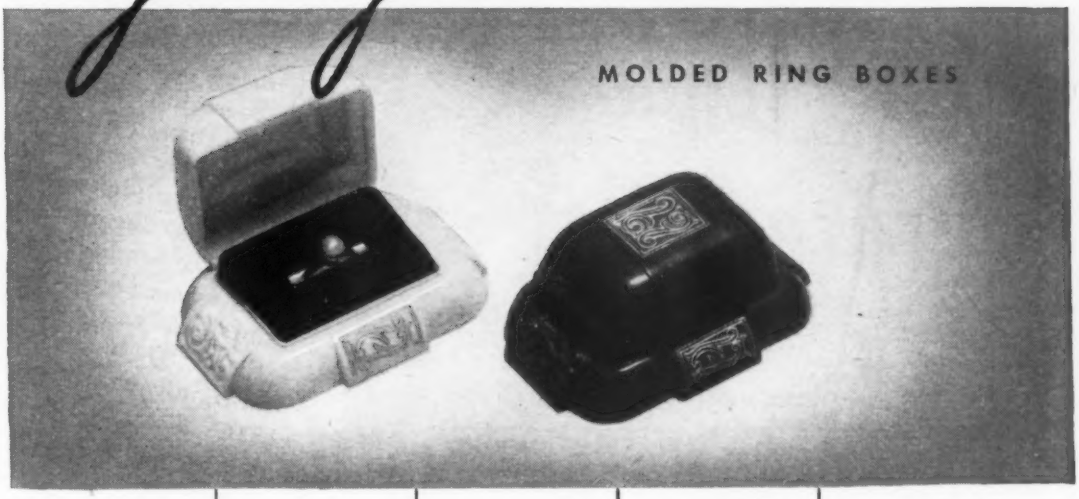
FOR AIR COMPRESSORS • AIRCRAFT, AUTOMOTIVE AND DIESEL ENGINES • ELECTRIC GENERATORS AND MOTORS • ELEVATORS • FANS AND BLOWERS • GOVERNORS • HOME APPLIANCES • MACHINE TOOLS • PUMPS • RAILROAD EQUIPMENT • ROLLING MILLS • STATIONARY AND PORTABLE ENGINES • STOKERS • TURBINES

PLASTICS IN THE *Packaging Field*



OTHER TYPICAL APPLICATIONS

PHENOLIC

Gift Box

Sewing Kit

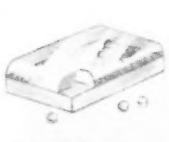
Tool Set

Razor Set

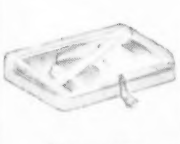
Game Set

THERMOPLASTIC

Cosmetic Kit

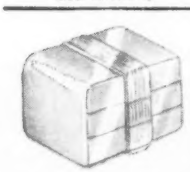

Capsule Container

Shaving Soap Bowl


Perfume Set

Watch Box

UREA


Stationery Box

Case for Glasses

Candy Box

Powder Box

Jewelry Box

TO REACH A SOUND CONCLUSION TO YOUR PROBLEM IN PLASTICS consult the skilled technicians—engineers and designers—of the General Electric Company. For advice on the successful application of plastics materials using all available processes of manufacture, write Section F-31, General Electric Company, One Plastics Avenue, Pittsfield, Mass., or call the General Electric Plastics Divisions' office nearest you.

Hear the General Electric radio programs: "The G-E All-girl Orchestra" Sunday 10 P.M. EWT, NBC. "The World Today" news every weekday 6:45 P.M. EWT, CBS. "G-E House Party" every weekday 4:00 P.M. EWT, CBS.

A G-E PLASTICS TECHNICIAN **KNOWS** PLASTICS

Buy War Bonds

GENERAL ELECTRIC

PD-31

Specify Ⓛ 46 for "Triple Protection"

LEBANON Ⓛ 46

CHEMICAL ANALYSIS

Cr. 25% Ni. 20% C. 0.25 Max.

PHYSICAL PROPERTIES
(Water Quenched for Corrosion Service)

Tensile Strength	70,000
Yield Point	30,000
Elongation in 2"	45%
Brinell Hardness	130

RESISTS HEAT, CORROSION AND PRESSURE IN COMBINATION

Where service conditions combine heat, corrosion and pressure, application of Lebanon Circle Ⓛ 46 should be thoroughly considered. Castings of this alloy provide outstanding service in such exacting installations as gas turbines, superchargers and in return bends where temperatures run above 1500° F. and where pressures are high.

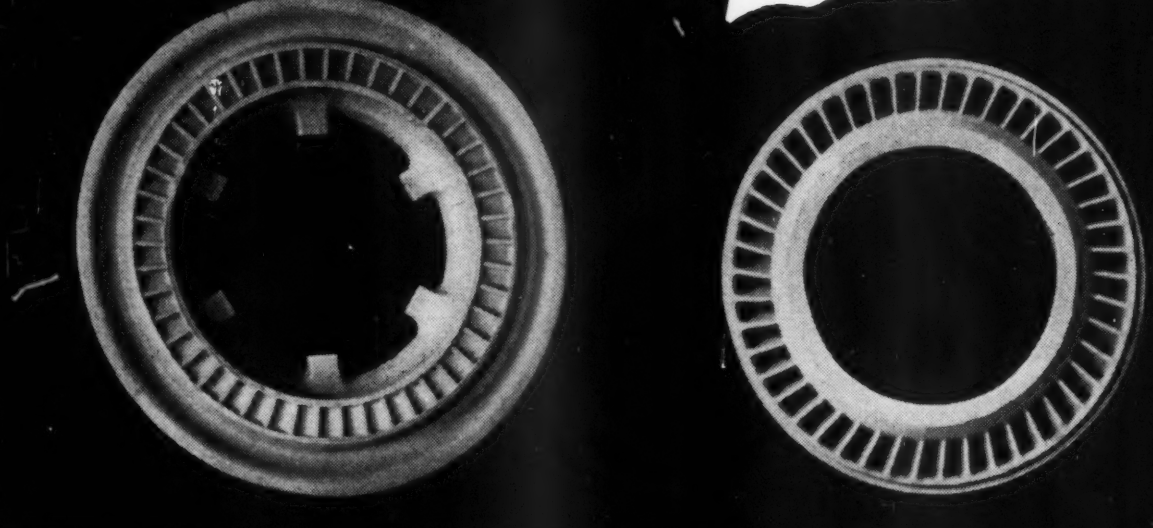
Circle Ⓛ 46 maintains strength and rigidity at all temperatures up to 1850° F. . . . resists fuels relatively high in sulphur . . . provides scale resistance superior to that of any 18% chrome and 8% nickel alloy.

Lebanon foundry engineers and metallurgists will gladly help you determine just where and how the use of Circle Ⓛ 46 will contribute to increased life or improved performance of your equipment. Write us and briefly outline your problems—or arrange for consultation.

LEBANON STEEL FOUNDRY **LEBANON, PA.**

ORIGINAL AMERICAN LICENSEE GEORGE FISCHER (SWISS CHAMOTTE) METHOD

Nozzle Diaphragm Castings.
Cast from Lebanon Circle Ⓛ 46.

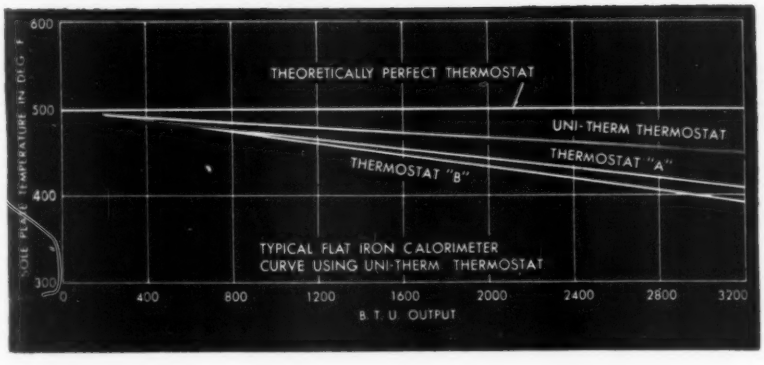


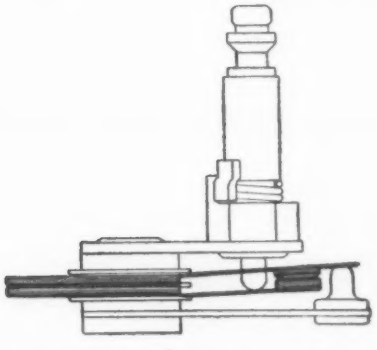
Lebanon ALLOY AND STEEL Castings

TEMPERATURE RESPONSE IS QUICKER BECAUSE HEAT PATH IS SHORTER IN THE

UNI-THERM

. . . THE CLOSE-CONTROL THERMOSTAT





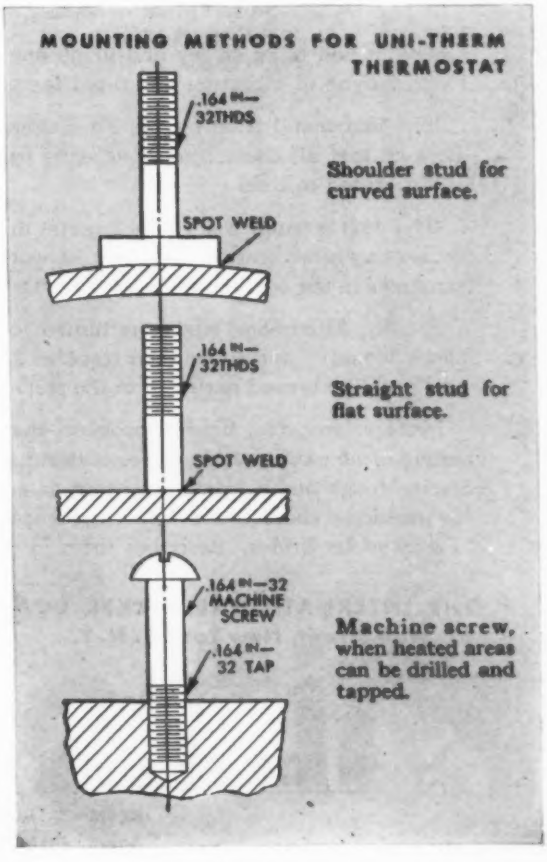
Uni-Therm's close approach toward perfect thermostat performance, as shown on the accompanying chart, is made possible by close metallic contact with the heated surface, thus shortening the heat path from heater surface to the actuating Bi-metal. Result—smaller differential between operating and thermostat temperatures . . . and more uniform temperature from no load to full load.

With this operating advantage, the *Uni-Therm* combines small size and simple, compact mounting. Typical mounting arrangements are: Shoulder stud for curved surfaces and straight stud for flat surfaces, or machine screws when heated areas can be drilled and tapped.

Typical *Uni-Therm* applications are: Ironing machine, dry and steam-type flatirons, and platens . . . wherever the thermostat must make a quick response to load changes.

For more information on the complete line of Westinghouse thermostats—on any heat control problem—call your nearest Westinghouse office, or write for B-3344 to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

J-10288


MOUNTING METHODS FOR UNI-THERM THERMOSTAT
.164 IN—32 THDS
Shoulder stud for curved surface.
SPOT WELD
.164 IN—32 THDS
Straight stud for flat surface.
SPOT WELD
.164 IN—32 MACHINE SCREW
.164 IN—32 TAP
Machine screw, when heated areas can be drilled and tapped.

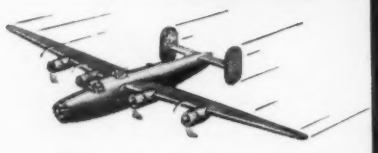
Westinghouse

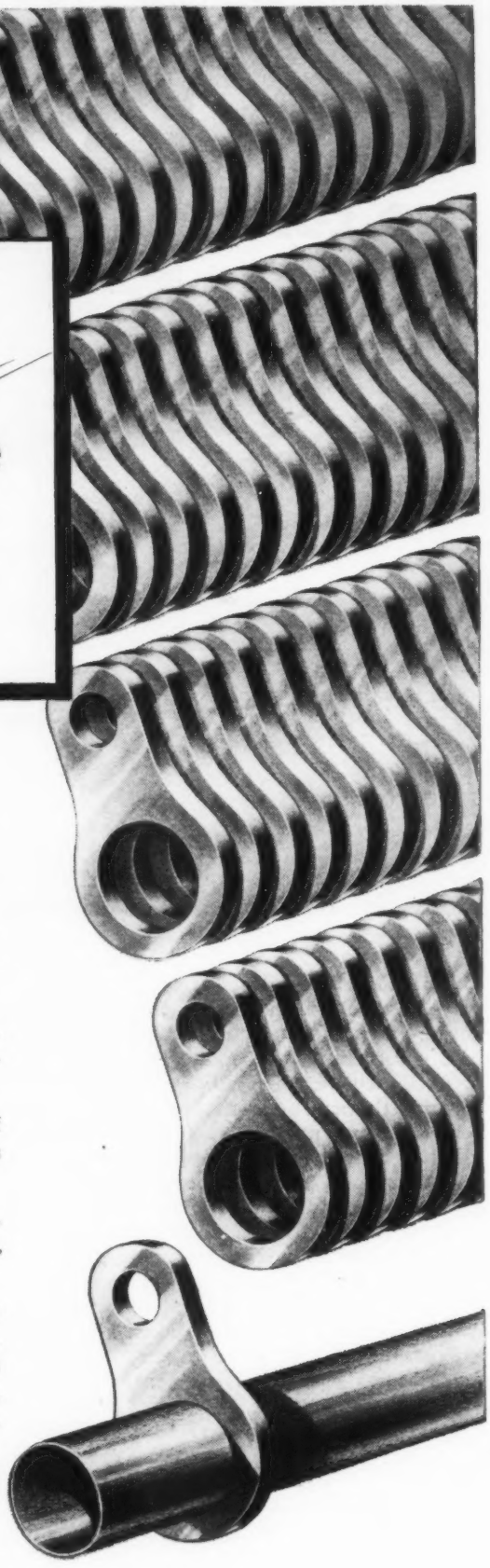
PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

HEATING UNITS AND CONTROLS

they wanted

to keep a flying plane GROUNDED!





The job called for a small metal stamping.

In use, it would be fitted around engine oil lines to provide a protecting ground to the frame.

It had to be rustproof.

It had to be readily brazed or welded to the steel oil line tubing.

And, it had to be strong and tough enough to withstand the combined fatigue of vibration and rapid temperature changes.

The first metal tried by the Fitzsimons Manufacturing Company, Detroit, met all these conditions, save one—it could not be satisfactorily brazed to steel.

The next attempt was to use a metal that could be *made* rustproof by coating after brazing. But, lack of workable stop-off devices plus pin-holes in the coating ran the reject rate to 20-30%.

Finally, Fitzsimons' engineers turned to the INCO Nickel Alloys... chose Monel... and ended their troubles. Monel was strong, rustproof, and could be brazed perfectly to the steel tubing.

Perhaps *you*, too, have a problem that could be solved by the unique *combination of properties* obtainable with INCO Nickel Alloys. Strong, tough and corrosion-resistant as a family, each also supplies the individual characteristics needed for specific jobs. A handy booklet, *"Tremendous Trifles,"* describes them in detail. Send for your copy.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

NICKEL (INCO) ALLOYS

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • "Z" NICKEL • NICKEL
Sheet..Strip..Rod..Tubing..Wire..Castings..Welding Rods (Gas and Electric)

PONCHO
WITH A FUTURE

THEY'RE WORKING OVERTIME in the Pacific now . . . these remarkable fabric coatings that will work wonders for *you* tomorrow! Made from VINYLITE dispersion resins, they transform a gossamer-like fabric into a tough, watertight material for ponchos . . . ponchos that "double in brass" and serve as rainwear, bedroll covers, foxhole covers, ground sheets, and pup-tents rolled in one. They "look as good as new" after months of the hardest usage.*

Raincoats of this lightweight coated material shed water like a duck . . . weigh less than a pound. Fold such a garment and it makes hardly a bulge in a briefcase or in a woman's handbag. But coatings of VINYLITE dispersion resins are equally applicable to *all* textiles They make *all* fabrics tough, abrasion-resistant, inert to chemicals, and oblivious to weather. Stains and soil are removed with a wipe of a damp, soapy cloth. They don't crack or become sticky, despite folding and crumpling. And coatings of VINYLITE dispersion resins can be made in clear transparent and in any desired color.

Write Department 10 for detailed information that will show you how to obtain the benefits of these superior coatings at low cost.

*Ponchos by S. Buchsbaum & Co.

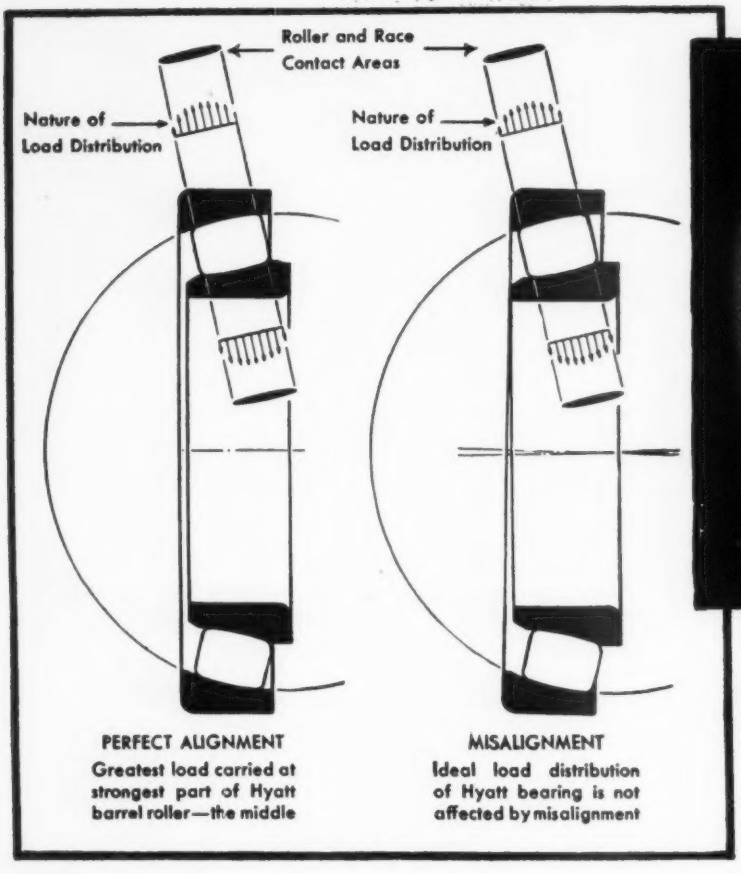
BAKELITE CORPORATION
Unit of
Union Carbide and Carbon Corporation
UCC
30 EAST 42ND ST., NEW YORK 17, N.Y.

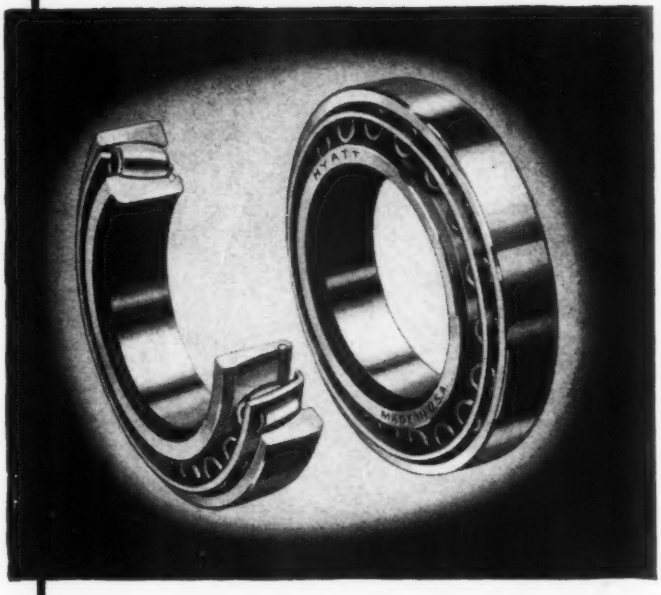
The perfect ground covering and shelter top for foxholes — watertight — impervious to mould and fungi.

Vinylite Plastics

FOR RADIAL AND THRUST LOADS...

yet freely self-aligning


Roller and Race Contact Areas
Nature of Load Distribution
Nature of Load Distribution
PERFECT ALIGNMENT
Greatest load carried at strongest part of Hyatt barrel roller—the middle
MISALIGNMENT
Ideal load distribution of Hyatt bearing is not affected by misalignment



BEARINGS: *HYATT*

Spherangular Type

In Hyatt Spherangular Bearings the curved operating surfaces of the rollers and races provide perfect freedom for alignment. Cramping of the rollers due to shaft deflection or other misalignment, cannot occur.

Ideal load distribution is maintained even in a condition of misalignment. The sketches above illustrate the similarity in the nature of load distribution and contact areas between rollers and races for conditions of perfect alignment or misalignment. Note that the load is concentrated toward the strongest part of the barrel-shaped roller, its largest diameter.

☆

The spherical contour of the outer race operating surface and the angular contact between rollers and races are indicated in the trade name Spherangular applied to this bearing.

HYATT BEARINGS DIVISION · GENERAL MOTORS CORPORATION

HARRISON, NEW JERSEY

"Electrolytic Corrosion" is his name.

He works slowly . . . quietly . . . continuously . . . and unobserved.

His prey is sub-surface cables, pipe lines and other metallic structures.

Unchecked, he can markedly shorten the life of buried equipment.

Yet, there *is* a way to protect your underground installations . . . *use Federal Cathodic Protection Rectifiers.*

These equipments, incorporating Federal Selenium Rectifiers to convert alternating current to direct current, send a steady current through the earth surrounding underground metal structures, counteracting the natural forces of corrosive galvanic action.

Federal Cathodic Protection Rectifiers are now at work in all parts of the country . . . mounting silent, motionless guard over buried investments.

Stop deterioration of your equipment now. Put Federal Cathodic Protection Rectifiers to work for you . . . cost of operation is low . . . attention required is negligible.

Write us today for the FTR Technical Information Series booklet "Cathodic Protection and Applications of Selenium Rectifiers"...get the full story on this effective means of protection.

FEDERAL TELEPHONE & RADIO — FTR

Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE

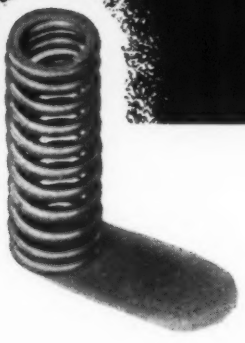
Newark 1, N. J.

★ Twisting a piece of wire sounds like a simple matter, but actually, in the making of better springs, it is quite a significant operation. By evaluating the results of a twist test, the Muehlhausen spring technician is able to select stock that will withstand the torsional strains to which springs are subjected in use.

In this test, a specimen of wire, held between two chucks of a specially designed laboratory machine, is twisted clockwise and counter-clockwise a predetermined number of times. Weakness is revealed by premature breakage or the opening of hidden seams. Only wire that can withstand the punishment of the twist test is approved for production.

Scores of such tests are conducted daily at Muehlhausen to make sure that every spring leaving this factory will perform with maximum efficiency and long life.

MUEHLHAUSEN SPRING CORPORATION
Division of Standard Steel Spring Company
810 Michigan Avenue, Logansport, Indiana

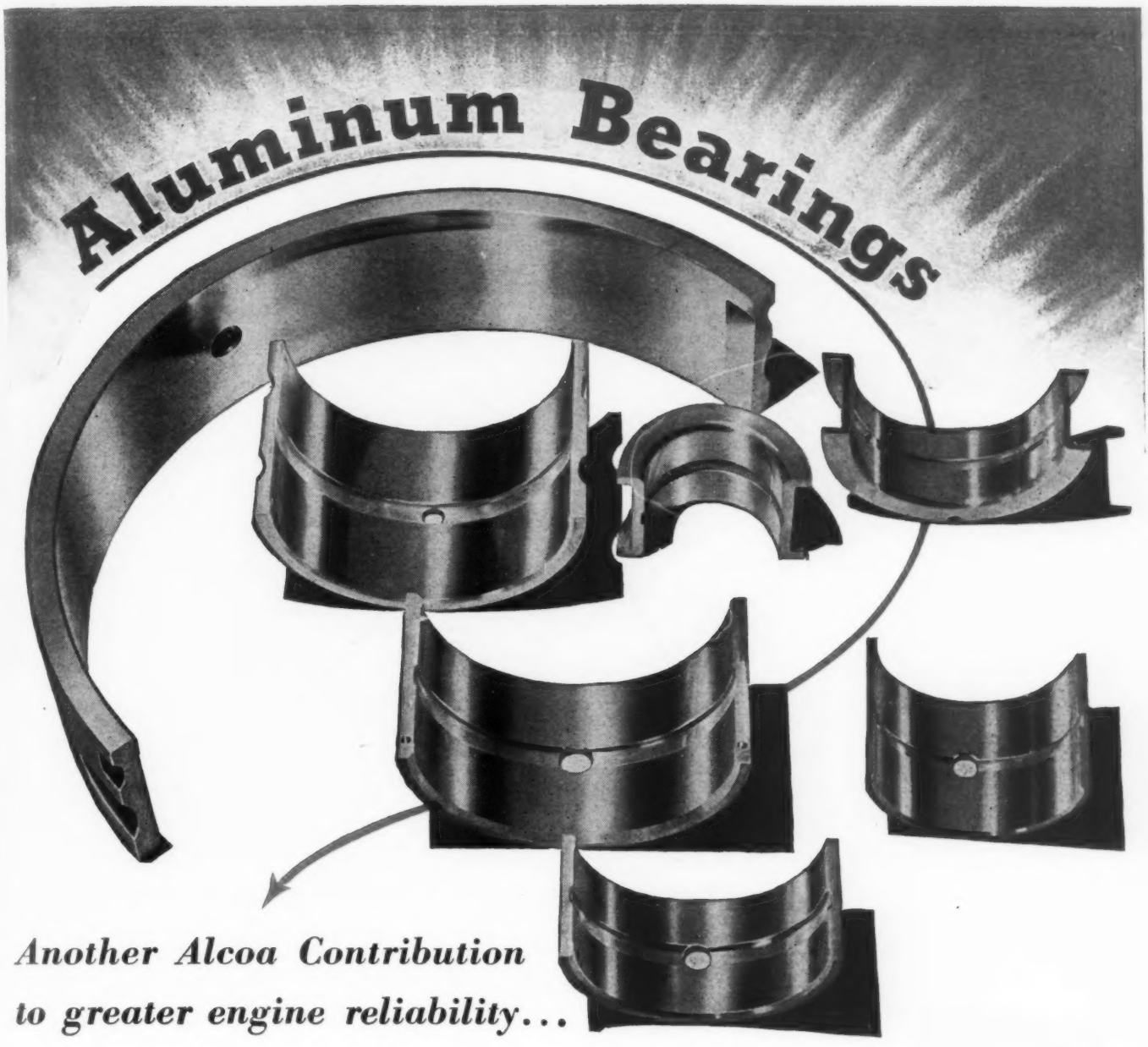


TWO NEW FOLDERS—FREE

New booklet explains factors involved in correct spring design. Die Spring Bulletin illustrates, describes 206 sizes and types of die springs.

MUEHLHAUSEN
SPRINGS
EVERY TYPE AND SIZE

Aluminum Bearings



Another Alcoa Contribution to greater engine reliability...

You can safely operate Alcoa Aluminum bearings at higher loads. This is a proved fact—proved repeatedly under scientific control on the test floor and under the varied circumstances of severe routine service.

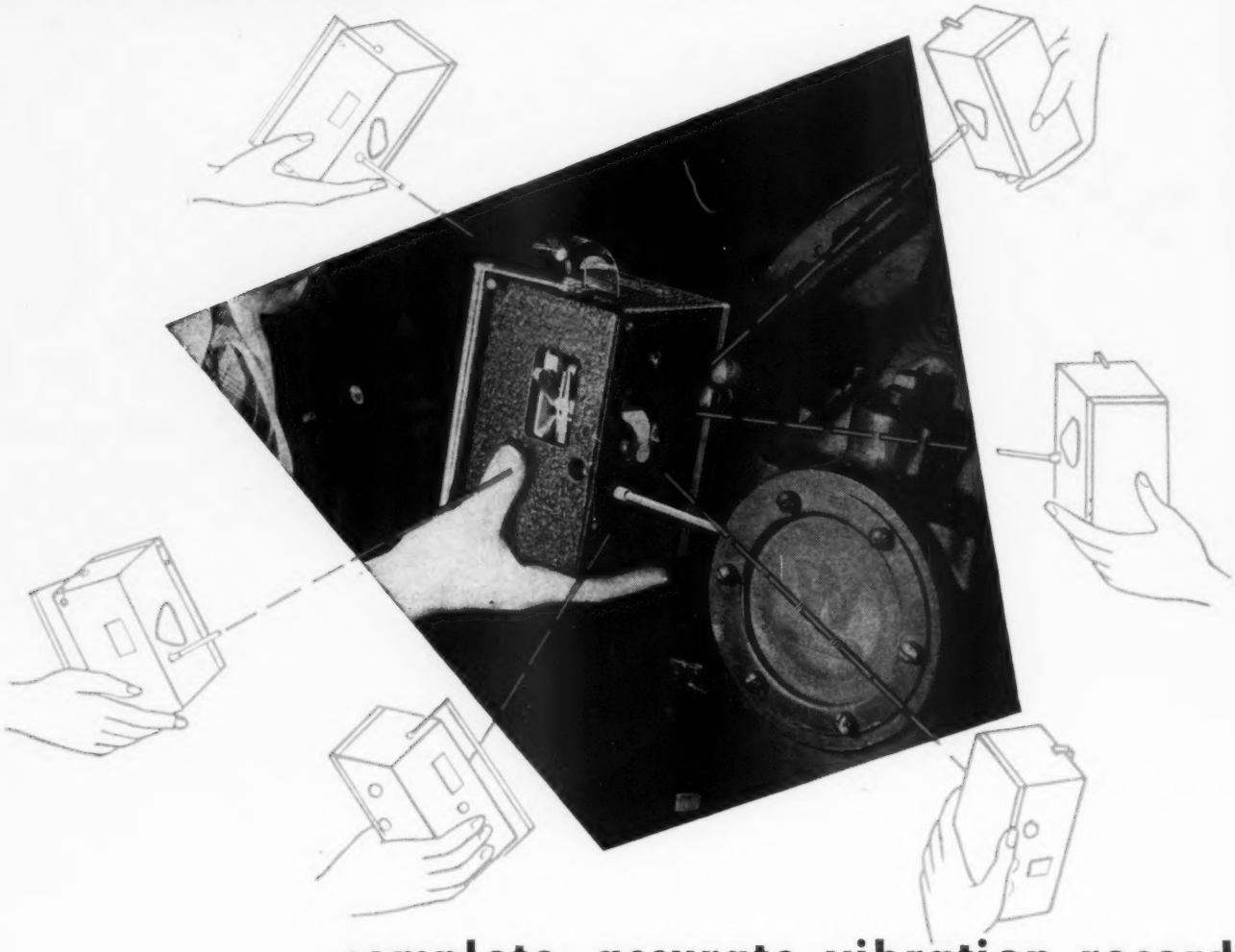
These bearings are bearing metal clear through. Alcoa bearing alloys offer excellent bearing characteristics. Their high heat conductivity lowers surface temperatures.

Don't be surprised when an engine builder gives you this evidence of a big step forward—"We're using Alcoa Aluminum bearings for better performance and greater reliability." A number of manufacturers have standardized on them for their heavy-duty work. ALUMINUM COMPANY OF AMERICA, 2193 Gulf Bldg., Pittsburgh 19, Pa.

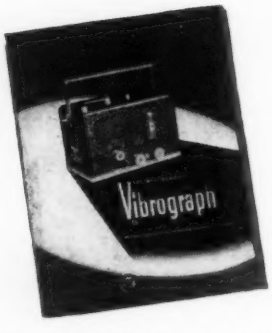
ALCOA FIRST IN **ALUMINUM**

ALCOA ALUMINUM

from any angle



complete, accurate vibration records



What the Vibrograph does, where it can be used, how it operates, is described in a new illustrated booklet, B-3406. Write to your nearest Westinghouse office for a copy today. Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pennsylvania.

On the ceiling—under your machine—or back in a corner—vibrations can start *anywhere*. The worst ones often are the hardest to reach. That's why the new Westinghouse Vibrograph is built to give you complete, accurate vibration records *from any angle*.

With this entirely self-contained *portable* instrument you can get an instantaneous and permanent record of *all* the vibrations at any point.

Seismic operation gives a graphic record of displacements on any vibrating surface where the base of Vibrograph can be rested. Prod operation provides a method of getting this same graphic record for those inaccessible points that only a prod will reach.

For either method of operation (and the change-over is made by a mere twist of the wrist) you'll get immediate results—no external connections to make, no data to tabulate, no films to develop. The Vibrograph *automatically* records the frequencies and amplitudes of all vibrations from 600 to 15,000 cycles per minute, for amplitudes as small as .0001″ or as great as 1/16″. And the accuracy is the same for the first or the ten thousandth reading—there are no parts to wear or get out of adjustment.

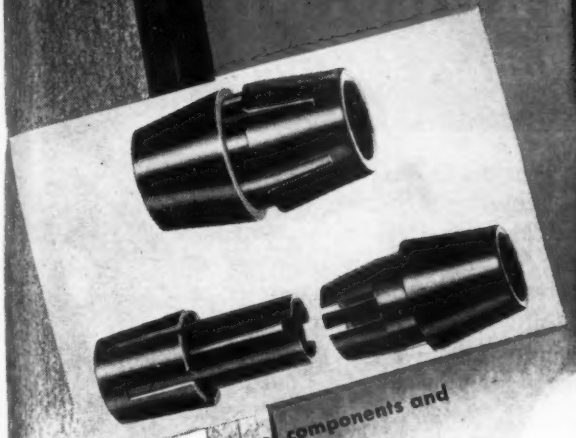
J-08092

Westinghouse

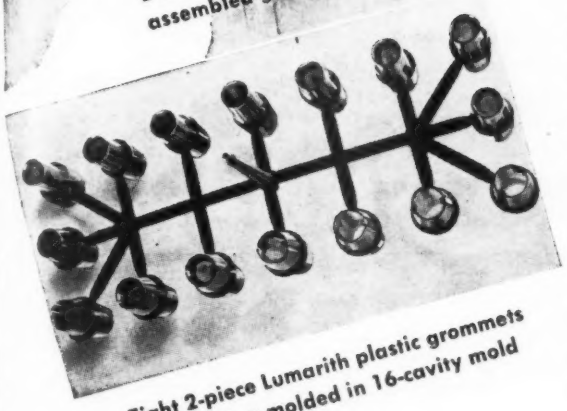
Vibration Analysis

Instruments

PERHAPS YOU WOULDN'T THINK OF USING *Plastics* HERE



Des-Grommet components and assembled grommet



Eight 2-piece Lumarith plastic grommets are injection molded in 16-cavity mold

A product designer did . . . producing a new and improved grommet design using a special flame resistant Lumarith* CA formulation.

THERE ARE sound reasons why Jan De Swart of Victory Manufacturing Company turned to Lumarith plastics when he developed the "Des-Grommet" for use on U. S. naval vessels. In abrasion tests using braided metal cable the Lumarith grommet showed less deterioration than did grommets made of lead, and caused far less wear to the braided cable than steel grommets did.

By taking full advantages of the physical characteristics of Lumarith, the Des-Grommet is designed to be self-locking, capable of blind installation (from one side of partition), and adjustable to as many as five different wall thicknesses. A special *non-burning* formulation of Lumarith CA (cellulose acetate) was used to meet Maritime Commission requirements for fireproof material.

The use of Lumarith in place of metal reduces production time and manufacturing costs. Grommets are injection molded in a matter of seconds—using multiple cavity molds. Finishing and polishing operations are reduced to a minimum. No machining, plating or enamelling is required.

The development of the Des-Grommet is a good example of the right approach to plastics. It is the type of project that the technical staff of Celanese is prepared to help you accomplish with your product. Your inquiries are invited. Celanese Plastics Corporation, *a division of Celanese Corporation of America*, 180 Madison Avenue, New York 16, New York.

LUMARITH*

A Celanese Plastic*

*Reg. U. S. Pat. Off.

ENGINEERING BACKGROUND

A Traditional Quality of Mallory Contacts

WITH 22 years of engineering experience in developing improved alloys and materials for contact applications—in designing all types of contacts and contact assemblies—and manufacturing them with precision—Mallory is ready to supply electrical contacts or contact assemblies with the extra measure of quality that assures improved performance in your equipment. During this period, over 5,000 designs have been developed by Mallory engineers to establish a wealth of contact "know how."

The *design* best adapted to your contact application is manufactured by Mallory from the most suitable *materials* . . . for Mallory provides contacts of tungsten, silver, platinum, Elkonite*, Elkonium* and other Mallory alloys in various combinations. Whether you want complete contact assemblies, individual contacts, or contacts attached to brackets, springs, studs, or arms Mallory has the facilities for a large production run or a small order.

Manufacturers of relays, industrial controls, circuit breakers, business machines, home appliances and other electrical and electronic equipment rely on Mallory—Contact Headquarters. Make it a policy to consult Mallory engineers *before* your designs are blueprinted.

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

*Reg. U. S. Pat. Off. for electric contacting elements.

When Wire Coils Must Be

OVEN-BAKED FASTER

FORMEX* Still Won't Crack

because the insulation on Formex magnet wire is highly resistant to heat shock

One way to speed coil production is to use higher temperatures and faster cycles in the baking process. Ordinary enameled wire can't stand such treatment, but Formex magnet wire *can!*

The superior toughness of the insulation on Formex enables it to withstand far more abuse in coil manufacture than other wires—in baking, bonding, winding, forming, and handling. This greater toughness affords you an opportunity to reduce rejects while maintaining top-speed production.

Because it needs no fibrous covering, and because it is available in rectangular and square shapes throughout a wide range of sizes, Formex makes possible more compact windings with resultant savings in weight and materials.

As the world's largest user of magnet wire, General Electric makes the same sort of comparisons of installed costs as you might make. These comparisons show that, even in those few cases where the price of Formex is slightly higher than the price of conventional magnet wire which it replaced, the higher first cost is definitely offset by lower costs of manufacturing the completed coil or installed winding.

Ask your G-E representative to show specifically how you can benefit by using Formex. *General Electric Company, Schenectady 5, N. Y.*

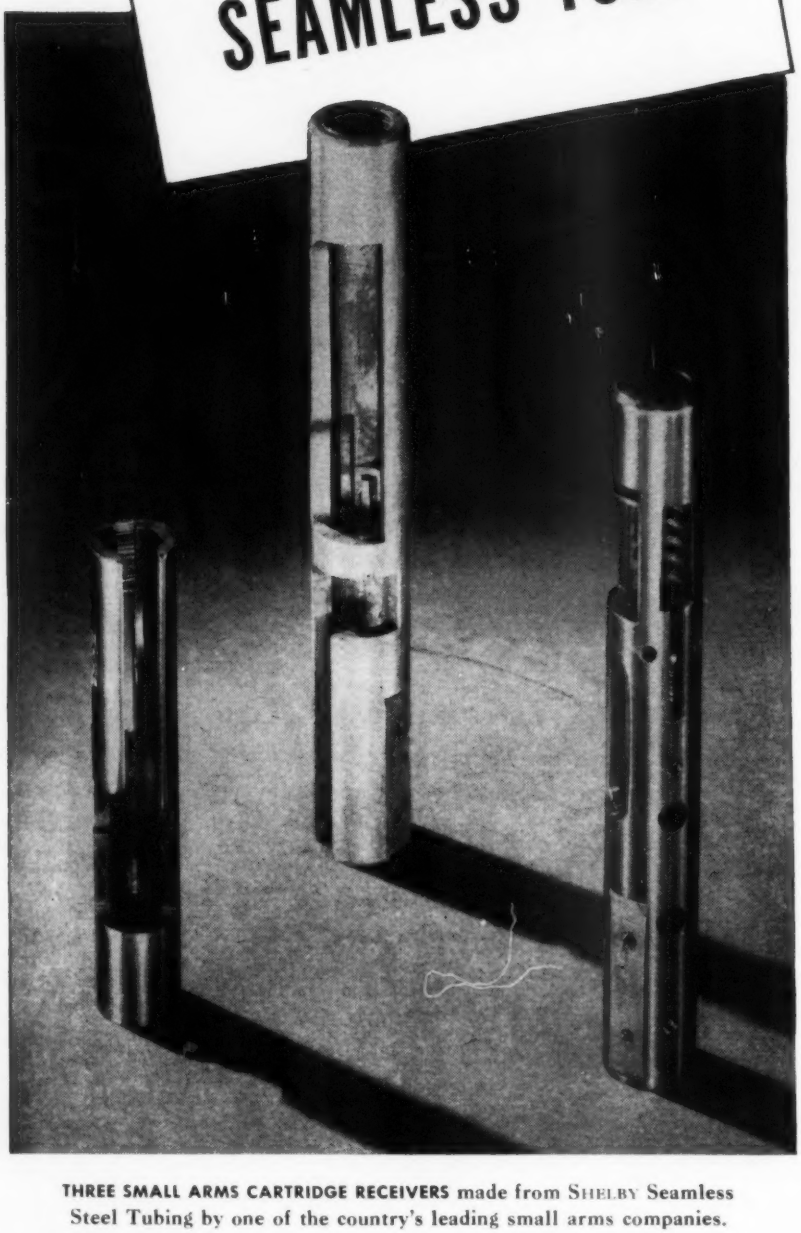
Round wire sizes: No. 8 Awg to .001 in.
Rectangular wire: Full range of sizes

*Trade-mark Reg. U.S. Pat. Off.

Buy all the BONDS you can—and *keep all you buy*

GENERAL ELECTRIC

A time saving idea was born in a SEAMLESS TUBE



THREE SMALL ARMS CARTRIDGE RECEIVERS made from SHELBY Seamless Steel Tubing by one of the country's leading small arms companies.

. . . and a better product resulted!

IN the exacting production of small arms, certain steel parts must have a normal grain in order that a special finish may be obtained. The life of many an American soldier depends upon the ease, rapidity and reliability of the magazine action of rifles and carbines.

During the manufacturing operations the cartridge receivers have to be drilled, reamed, tapped, threaded, milled, broached, upset and ground to gauges provided and rigidly maintained by the Army Ordnance Department.

Valuable time and money were saved, and an ideal finish was produced when SHELBY Seamless Steel Tubing was used instead of forgings. The number of operations was reduced, and there was a saving in the tonnage of raw material. Due to the uniform hardness of the tube steel, longer life was given to the tools used in the various machining processes.

These cartridge receivers form an excellent example of how the adaptation of SHELBY Seamless Tubing can result in a better product. There are many war and peacetime industrial products which can be manufactured from steel tubing more satisfactorily, more cheaply and more quickly than from solid forgings.

Our service engineers have had ample experience in this direction, and have given valuable assistance to many companies. Perhaps they can help you? If you have a problem of this nature, their services are at your disposal for consultation.

WALLS WITHOUT WELDS

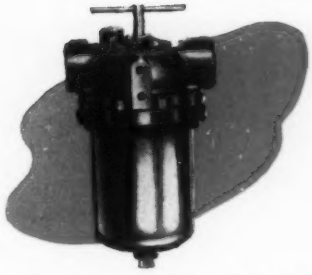
NATIONAL TUBE COMPANY

PITTSBURGH, PA.

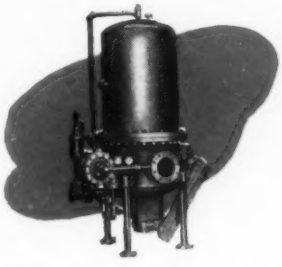
Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Export Company, New York

NATIONAL TUBE COMPANY · USS STEEL · UNITED STATES STEEL

UNITED STATES STEEL



AUTO-KLEAN *disc-type.* For all fluids except those containing highly abrasive solids. Viscosities from 30 to 50,000 Saybolt Seconds. Cleaner blades give positive mechanical cleaning of filter element (manually or motor-driven). Handles full flow, yet no larger than usual partial-flow type. Minimum pressure drop. Continuously cleanable. Sizes from 1¼" diam. x 7/8" cartridges to massive motor-driven models. With variety of built-in types.



FLO-KLEAN *wire-wound.* For fluids containing highly abrasive solids such as metal chips, abrasive wheel particles, sand, etc. May be designed to remove particles .0025" or larger. Motor-driven backwash nozzle gives positive hydraulic cleaning of filter element. Low pressure drop — fluid moves in straight line, encountering only momentary restriction. All parts made of metal — constructions to meet varying corrosive and erosive conditions.

AIR-LINE *for compressed air.* Removes solids, entrained moisture and oil from compressed air. It is an edge-type filter of metal disc construction. Brass element has .0015" spacing. No cleaner blades. Removal of trapped dirt, water and oil is accomplished by opening petcock at bottom.

★ ★ ★

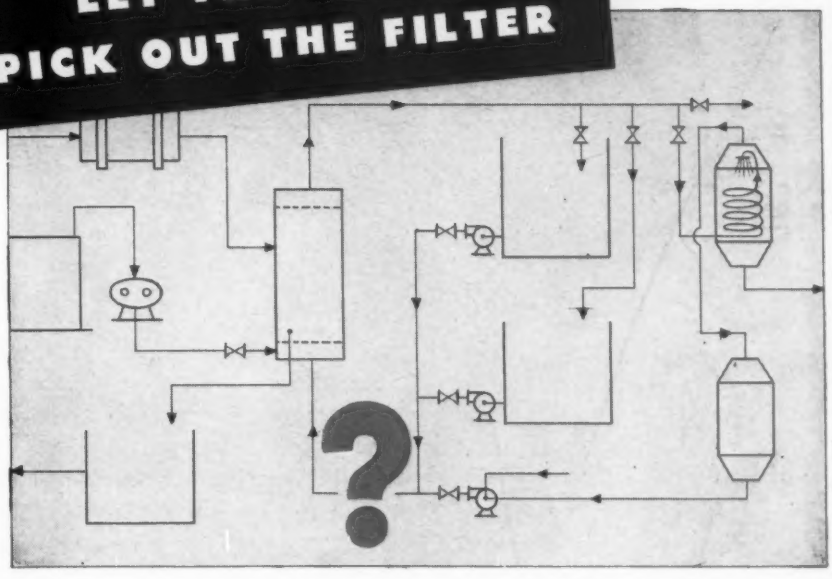
Catalog of filter selection factors and specifications will be found in SWEET'S. Or inquire for specific information on your type of application by sending us the coupon — no obligation.

KEEP FLOW ON "GO" WITH

CUNO

THE "FILTER-FINE" STRAINER

LET THE FLUID PICK OUT THE FILTER



In the Cuno line you'll find the right type for the fluid . . . the flow . . . the physical conditions

Start with the nature of the fluid — acid, alkaline or neutral, corrosive, inert, stable, unstable, etc. — and the nature of the solids it carries, the minimum size to be removed. Consider the flow — gravity, suction or pressure, maximum velocity, allowable pressure drop. And the temperature at filtering point, viscosity, operating conditions.

Then decide how clean the fluid should be — how clean it is to start with, and how clean it should be kept. When these matters have been settled, the choice of a fluid-cleaning method is easy — because, in the Cuno line, you will find the filter that will keep flow on "Go".

Three of the several *types* of filter Cuno offers are shown here. Adaptations of these are often made, under the direction of Cuno's engineering staff, to meet special service conditions. Have us send you a copy of the Cuno Catalog. There is a coupon below for your convenience.

CUNO ENGINEERING CORPORATION
307 South Vine Street, Meriden, Conn.

Please send me a free copy of your new catalog. I am especially interested in the services checked.

- ☐ Air Actuated Instruments
- ☐ Air Tools
- ☐ Bakery Machinery
- ☐ Balers
- ☐ Blowers
- ☐ Boiler Feed
- ☐ Coal Loaders
- ☐ Coating Machinery
- ☐ Combustion Equipment
- ☐ Compressors
- ☐ Controls
- ☐ Cooling Systems
- ☐ Crushers
- ☐ Diesel Engines
- ☐ Dip Tank Systems
- ☐ Drilling Machines
- ☐ Engines
- ☐ Gear Hobbing Machines
- ☐ Grinders
- ☐ Hobbing Machines
- ☐ Honing Machines
- ☐ Hydraulic Systems
- ☐ Incubators
- ☐ Instruments
- ☐ Lathes
- ☐ Lubricating Systems
- ☐ Machine Tools
- ☐ Meters
- ☐ Milling Machines
- ☐ Oil Burners
- ☐ Oil Well Drilling Equipment
- ☐ Paint Spray Systems
- ☐ Paper Machinery
- ☐ Pneumatic Devices
- ☐ Power Transmissions
- ☐ Presses
- ☐ Printing Presses
- ☐ Pumps
- ☐ Radial Drills
- ☐ Rolling Mills
- ☐ Scrap Balers
- ☐ Spray Systems
- ☐ Superchargers
- ☐ Tapping Machines
- ☐ Test Stands
- ☐ Turbines
- ☐ Turret Lathes
- ☐ Welding Machines

Others .....

Name .....

Company .....

Address .....

Keeping Navy searchlight reflectors spotlessly clean is an unending job. The HAYNES STELLITE alloy, from which many reflectors are made, is so hard that constant cleaning and polishing will not mar its surface.

LIGHT ON THE RISING SUN

UNCLE SAM'S NAVY has the most efficient searchlights on the Seven Seas. They are so powerful that one of them measuring 24 inches across can shoot a beam of light through 23 miles of inky darkness.

The reflectors of these searchlights are made of an alloy perfected and produced by HAYNES STELLITE COMPANY.

The Navy is using HAYNES STELLITE alloy for several reasons. It will not shatter from shock of gunfire. It has high resistance to corrosion by salt air, salt spray, powder and sulfur fumes. It withstands the terrific heat of the arc light—and hot particles of copper and carbon from the electrodes do not cause it to pit and lose its reflectivity. Searchlight reflectors are indicative of the many applications to which HAYNES STELLITE alloys — with their unique combinations of properties — can bring more efficient performance.

•

HAYNES STELLITE alloys have long been used for scientific mirrors, surgical and dental instruments and other equipment requiring great resistance to corrosion, wear and heat. Unending research is constantly adding to the variety of these alloys. They can be produced in many exacting shapes—in quantity—and delivered ready for assembly without further finishing.

A booklet describing the properties of Haynes Stellite alloys is available on request.

BUY UNITED STATES WAR BONDS AND STAMPS

HAYNES STELLITE TRADE-MARK

HAYNES STELLITE COMPANY

Unit of Union Carbide and Carbon Corporation

General Office and Works UCC Kokomo, Indiana

Chicago—Cleveland—Detroit—Houston—Los Angeles—New York—San Francisco—Tulsa

ARMY E NAVY

ABRASION- AND CORROSION-RESISTANT ALLOYS

"HAYNES STELLITE" is a registered trade-mark of Haynes Stellite Company.

ONLY A BELLOWS SEAL ASSEMBLY LIKE THIS . . .
CAN MEET OPERATING CONDITIONS LIKE THESE
PRESSURE: up to 100 p.s.i.
TEMPERATURE: sub-zero to 500°F.
VIBRATION: severe

It's a HYDRON . . . engineered by CLIFFORD

The *success* of the *automobile* fluid drive was, in a large measure, due to the satisfactory solution by Clifford of one of the most difficult shaft seal problems ever encountered.

Since the fluid drive was an entirely new development, its shaft seal had to be designed from scratch. It had to seal fluid in under high temperature, heavy pressure and severe vibration . . . also to seal air out when the motor idled at sub-zero temperature. Unlike applications that can be serviced on short notice, this one, by its very nature, placed a heavier burden on the shaft seal to give long, trouble-free service.

Clifford succeeded, where others had failed, not only by using Hydron (hydraulically-formed) Bellows but also by pioneering for this shaft seal new processes for (1) silver-soldering the thin-walled bellows to the end-fittings and (2) hardening the steel nose of the assembled unit without annealing the brass bellows.

Whether or not your problem is as difficult as that, Clifford is best equipped to design and manufacture your bellows seal assemblies for sealing rotary shafts or reciprocating valve stems for a wide range of temperatures and pressures.

Clifford also specializes in engineering bellows assemblies for controlling temperatures and pressures, for providing for expansion in pipe joints, etc. A discussion of your problem before your designs are too far advanced will save you time, trouble and money.

Clifford Manufacturing Co., Boston 27, Massachusetts.

HYDRON Metal Bellows

CLIFFORD

First with the Facts on Hydraulically-formed Bellows

HYDRON

Feather-weight . . . the First All-Aluminum Oil Coolers and Coolant Radiators . . . Made with Hydron Tubing Brazed by Clifford's Patented Method.

CLIFFORD MANUFACTURING COMPANY

564 E. First Street, Boston 27, Mass.

Please send me information on Hydron Bellows Seal Assemblies. I am interested in using them in the equipment checked.

- ☐ Air compressors
- ☐ Fluid couplings
- ☐ Fuel oil pumps
- ☐ Gear boxes
- ☐ Paper machinery
- ☐ Refrigerant compressors
- ☐ Textile machinery
- ☐ Torque converters
- ☐ Washing machines
- ☐ Water pumps

Other applications.....

NAME.....

COMPANY.....

ADDRESS.....

A "PROD" to Production

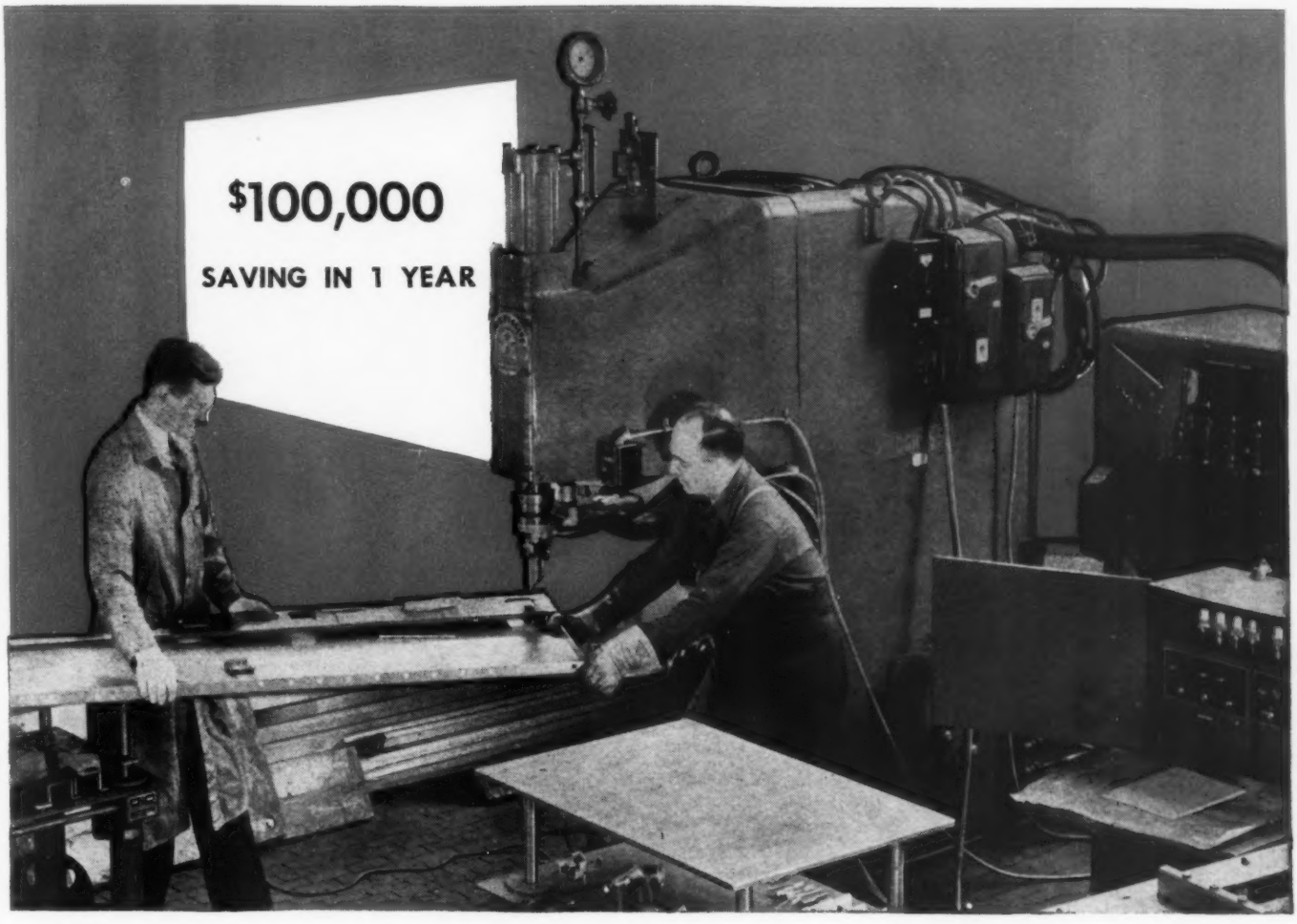
ASSEMBLY-"WISE" SPRINGS

BARNES-made springs fall into perfect step with other parts on your production lines —fitting into place with a minimum of effort or time. That's because—once engineered and set-up for production, rigid controls govern every step in forming and heat-treating to maintain uniformity.

Barnes methods are geared to the great production lines of the nation—with facilities to meet continuous or emergency requirements. Here, in one organization, is everything you'll need for spring service: experimental laboratories, engineering skill, tool design, production testing, modern heat-treating, special finishes, and, of course, special machinery to produce the springs to your schedule.

Like the modern service station—it's one stop for spring production—*Barnes*.

WALLACE BARNES COMPANY DIVISION OF ASSOCIATED SPRING CORPORATION
BRISTOL, CONNECTICUT, U.S.A.



here's what came out . . . when electronics went in

A manufacturer of metal cabinets recently installed resistance welding with electronic control—to replace other forms of fabrication.

Here's what came *out* of his fabrication costs in one year: *600 tons of steel, 10,000 man-hours of labor, 3,000 pounds of welding rod.* The total saving amounted to $100,000.

The reasons? Resistance welding with precision electronic control permitted use of lighter gauge stock in the whole structure—with strength and tolerances maintained. This, in turn, permitted better-planned shearing that greatly reduced scrap losses.

Resistance welding control is but one of the many ways electronics is serving industry as a production tool—speeding fabrication, cutting costs, improving products.

For full information on electronic applications for your industry, consult your nearest Westinghouse office. Or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-91080

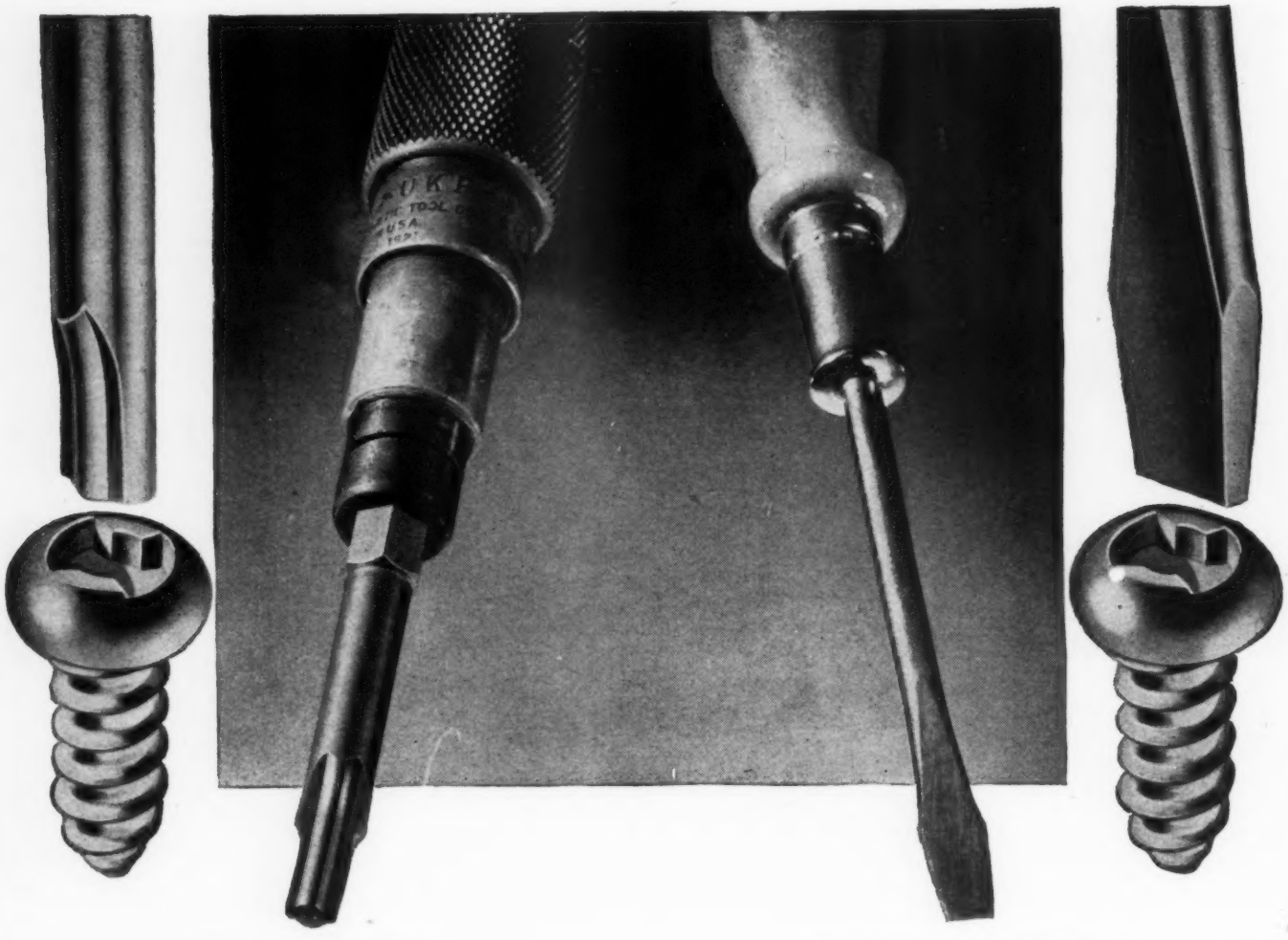
ELECTRONIC CONTROL for resistance welding equipment provides accurate control of weld time, heat and timing sequence. Through the precision of electronic tubes, accurately controlled electric current may be sent stabbing through metal as many as 1,800 times per minute.

TUNE IN JOHN CHARLES THOMAS, SUNDAY—2:30 EWT, NBC.

Westinghouse
PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Electronics at Work

ELECTRONIC EQUIPMENT FOR INDUSTRY AND HOME • ELECTRONIC TUBES • RADIO AND TELEVISION



TYPE "A" POWER BIT FOR

SAFER, FASTER, LOWER COST ASSEMBLY

AN EASY-TO-HIT TARGET. The visibility of CLUTCH HEAD'S wide roomy recess substitutes operator confidence for slow-down hesitation. Saves "breaking-in" period.

NO DRIVER CANTING. The Center Pivot column guides the bit directly into full-depth dead-center entry. Makes straight driving automatic.

NO "CHEWED-UP" HEADS to stop or slow up the line. Definite grip also protects manpower and material against slippage.

NO RIDE-OUT TENDENCY. With CLUTCH HEAD the driving contact of bit and recess walls is all-square. No "kick-out" as in tapered driving. Disposes of end pressure as a fatigue factor and slippage hazard.

EFFORTLESS DRIVING steps up speed for smoother, higher production. Checks out end-of-the-shift lagging.

DRIVE EXTRA THOUSANDS OF SCREWS with the rugged Type "A" Bit . . . without interruption for tool change.

NEW BIT LIFE IN 60 SECONDS. No back-to-the-factory shipment. Simple 60-second application of the end surface to a grinding wheel restores this bit to original efficiency.

THE COMMON SCREWDRIVER FOR

SIMPLIFIED FIELD SERVICING

THE ONLY MODERN SCREW on the market that is basically designed for operation with a common screwdriver.

FIELD SERVICE "HEADACHES" ELIMINATED. No time wasted hunting special tools. No needless multiple tool expense.

WIDTH THE ONLY FACTOR. The only requirement is that the screwdriver blade be reasonably accurate in width. Thickness of the blade is secondary.

CUTS NON-OPERATING TIME. This simplified servicing expedites adjustments in the field to keep your product in consistent operation . . . an important selling point to users.

TYPE "A" HAND DRIVERS TOO. The same rugged bit is available for field service. While not essential, this bit has special advantages found in no other similar tool.

THE CLUTCH HEAD LOCK-ON enables service men to withdraw screws undamaged and saved for re-use, the reverse action securely locking the screw to the end of the Type "A" Bit. The same Lock-On feature operates in replacing screws, permitting of easy one-handed reaching to hard-to-get-at spots . . . frequently saving disassembling of surrounding units.

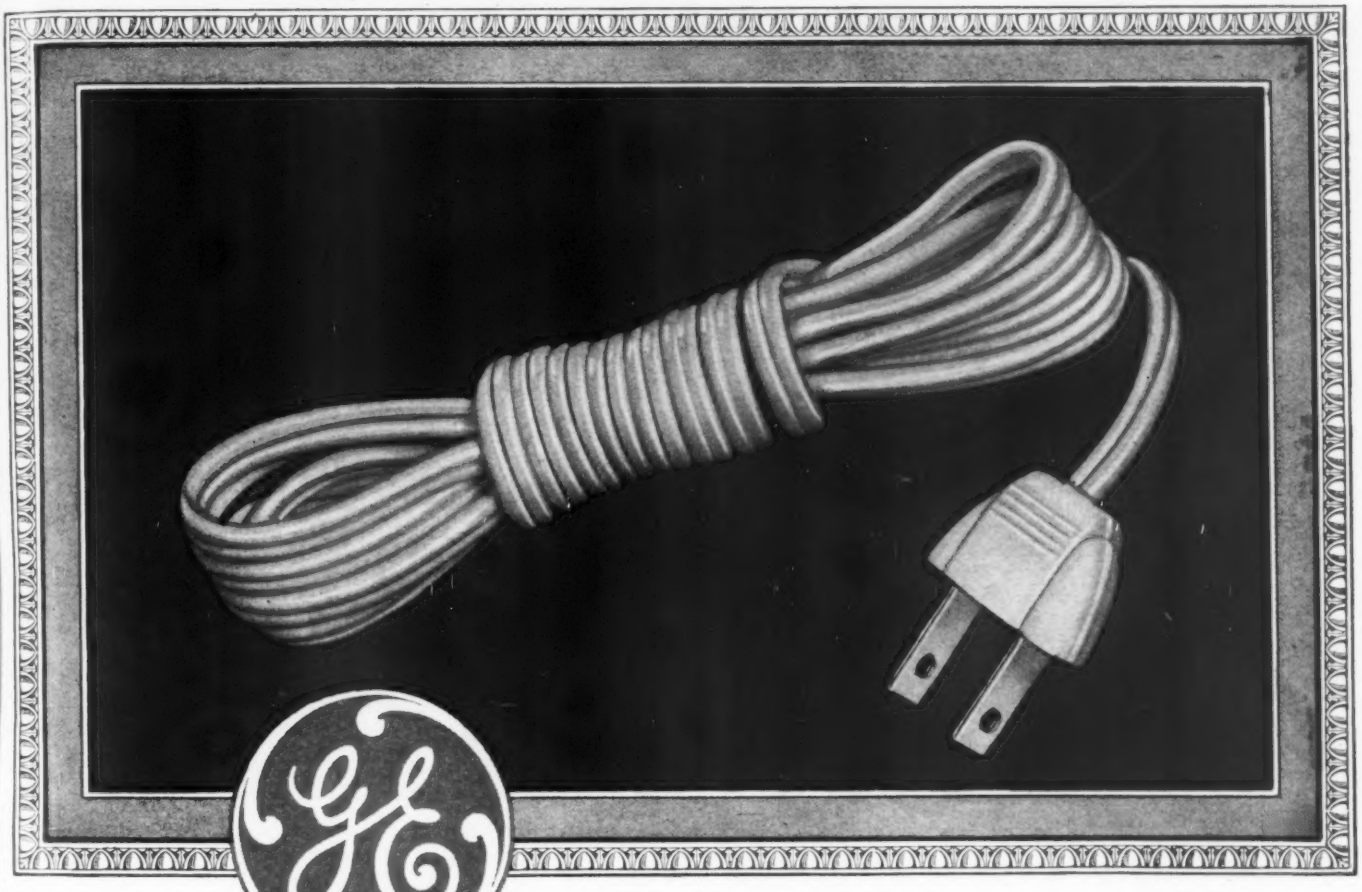
CLUTCH HEAD SCREWS

Investigate what these exclusive CLUTCH HEAD *features mean to you in reconversion. Write for details, illustrated Brochure, package assortment of screws, and sample Type "A" Bit.*

UNITED SCREW AND BOLT CORPORATION

CHICAGO 8 CLEVELAND 2 NEW YORK 7

Plan for Beauty and Safety



WITH FLAMENOL CORDS

Designed for a Class of Postwar Traffic Appliances and Portable Lamps

The new G-E Flamenol Cords are designed to add beauty and safety to a class of postwar traffic appliances and portable lamps. After victory customers will be influenced by eye-appeal of electrical products more than ever. That's why you'll want to investigate G-E's modern Flamenol Cords now—when your appliances are in the modeling stage.

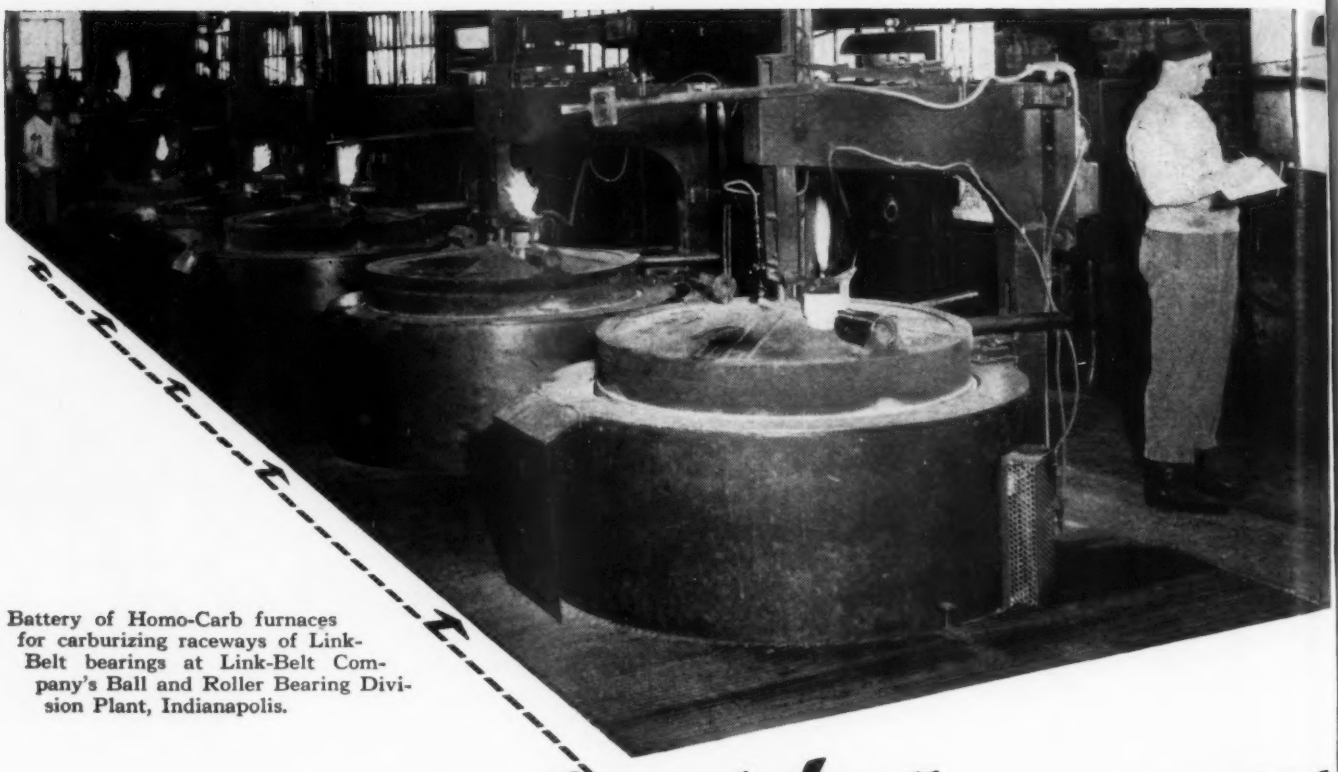
G-E Flamenol Cords' rich color, smooth texture and beautiful finishes will enhance your traffic appliances and portable lamps. Their striking appearance will set a new style in cord set design. And users will be more satisfied with the performance of their electrical appliances. G-E Flamenol Cords are made to last with the life of the electrical product. Oil does not deteriorate its sturdy composition nor sunlight adversely affect its fine finish.

Improve the saleability of your after-victory electrical products by planning now to equip with G-E Flamenol Cords. Section Q755–42, Appliance and Merchandise Dept., General Electric Co., Bridgeport, Conn.

Hear the General Electric radio programs: "The G-E All Girl Orchestra" Sunday 10 P. M. EWT, NBC. "The World Today" news every weekday 6:45 P.M. EWT, CBS. "The G-E House Party" Monday through Friday 4:00 P. M. EWT, CBS.

BUY WAR BONDS AND KEEP THEM

GENERAL ELECTRIC



Battery of Homo-Carb furnaces for carburizing raceways of Link-Belt bearings at Link-Belt Company's Ball and Roller Bearing Division Plant, Indianapolis.

A Red Hot Start to a Long Life of SERVICE!

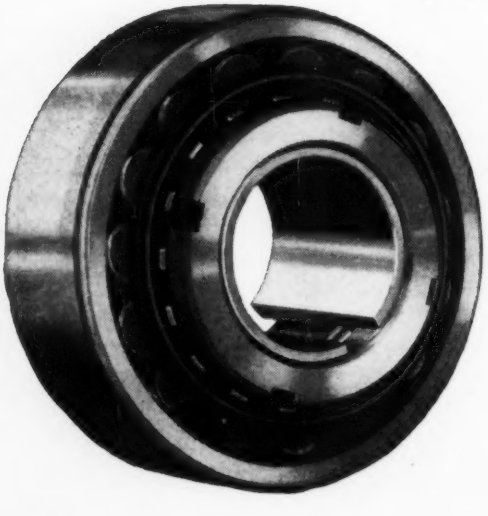
● "Right from the start" Link-Belt bearings are the product of the most scientific processes and precision control of every operation. Heat treatment of the raceways and rollers, under modern instrument control gives the toughness and wearability that assure long life, sustained accuracy and free-rolling efficiency.

Right from the start, and *right* at every stage, is the Link-Belt method, which makes the Link-Belt stamp of Quality your assurance of satisfaction.

Link-Belt bearings are made without mountings in ball and roller types, and as pillow blocks, and cartridge, flanged, take-up hanger or duplex units. Send for engineering data book No. 1775-A.

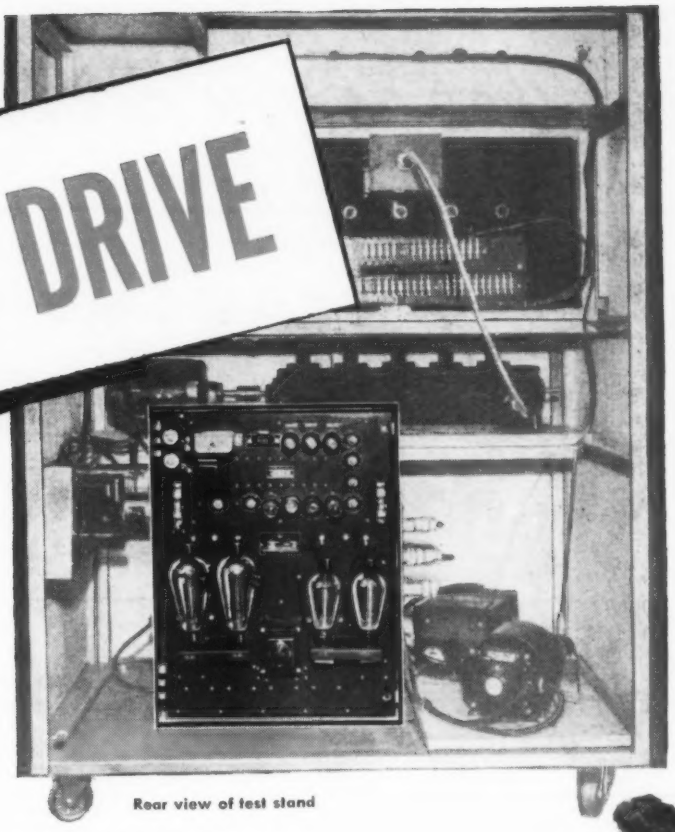
LINK-BELT COMPANY

Builders of the most complete line of power transmission machinery.
Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices, Factory Branch Stores and Distributors in Principal cities. 8043



LINK-BELT
BALL AND ROLLER BEARINGS

a-c powered ELECTRONIC DRIVE



Rear view of test stand

GIVES A WIDE RANGE OF SPEEDS FOR TACHOMETER TESTS AT LOCKHEED

Wide speed range, increased accuracy, and simplified operation were the results of installing G-E Thy-mo-trol drive on this tachometer generator test stand of the Lockheed Aircraft Corporation.

Five tachometer generators, all driven by the ¼-hp Thy-mo-trol drive, can be tested simultaneously. A simple turn of the Thy-mo-trol control dial gives each of the desired speeds during testing, and the ability to hold speed precisely adds to the accuracy of the test. Test readings are made every 200 rpm, between 200 to 4000 rpm, by comparing the tachometer indicators with a master stroboscope disk.

This is just one of an ever-increasing number of applications of Thy-mo-trol drive, which offers unusual advantages to designers of machines, such as testers, machine tools, welders, and coil winders.

Thy-mo-trol drive offers you all the desirable characteristics of d-c shunt motors, yet it operates from an a-c power supply. From a single, compact control station, the drive is started, stopped, and reversed, and the speed is adjusted. Acceleration is electronically controlled. The motor is fully protected, and is stopped quickly by dynamic braking.

At Lockheed, the Thy-mo-trol electronic panel (shown above) is installed in the back of the test stand, and is readily accessible for inspection. The control dials are mounted on the front of the stand, and are easily adjusted by the operator.

Standard Thy-mo-trol drives (each includes d-c motor, electronic panel, transformer, and control station) are available from ⅛ to 25 hp. G-E engineers will help you select and apply them to your machines or explore their suitability for new applications. Ask for Bulletin GEA-4025. *General Electric Company, Schenectady 5, N. Y.*

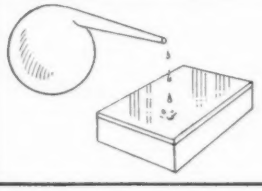
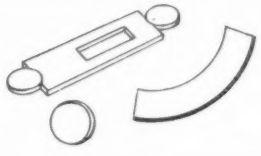
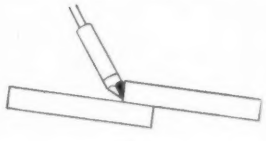
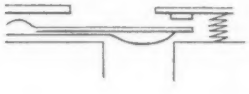
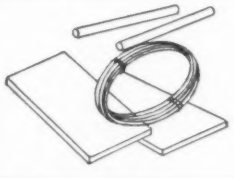
Buy all the BONDS you can—and keep all you buy

GENERAL ELECTRIC

676-179-8930

THY-MO-TROL DRIVE

What do you need in metals ?

ECONOMY	
CORROSION RESISTANCE	
EASE OF FABRICATION	
EASY SOLDERING	
ELECTRICAL CONDUCTIVITY	
SHEET, WIRE, TUBE	

You'll find the answer in General Plate Laminated Metals

The versatility of General Plate Laminated Metals makes possible the fabrication of parts with exceptional electrical performance . . . corrosion resistance . . . mechanical and structural properties . . . long wearing life . . . and economy.

By permanently bonding precious metals to base metals, General Plate Laminated Metals give you solid precious metal performance at a cost slightly higher than the base metal. Base to base metal combinations provide special performance requirements not found in single base metals.

No matter what your metal requirements in such applications as electronic devices, electrical products, signal control apparatus, chemical equipment . . . anything from peanut radar tubes to giant turbines, it will pay you to investigate General Plate Laminated Metals for present and post-war products.

They are available in sheet, wire and tube form . . . inlaid or wholly covered . . . or as fabricated parts. Many new clad combinations, developed since the war, are also now available. Our engineers are available for consultation. Write for their services.

General Plate Division

of Metals & Controls Corporation

50 Church St., New York, N. Y.; 205 W. Wacker Drive, Chicago, Ill.; 2635 Page Drive, Altadena, California; Grant Bldg., Pittsburgh, Pa.

ATTLEBORO, MASSACHUSETTS

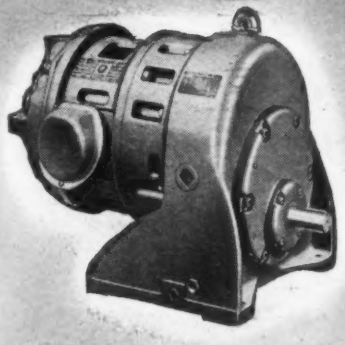
Nine good reasons for

Modernizing with Westinghouse Gearmotors

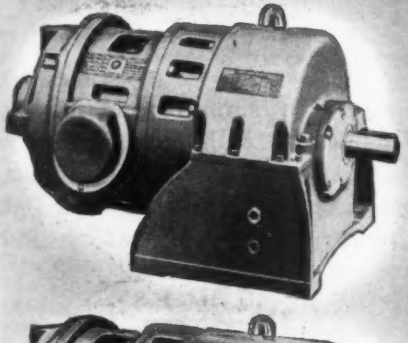
on drives from 1 to 75 hp

1. FEWER PARTS TO WEAR
2. BPT "TOUGH-HARD" GEARS AND PINIONS
3. USE ALL WESTINGHOUSE MOTOR TYPES
4. HIGH EFFICIENCY
5. POSITIVE LUBRICATION
6. EASY ACCESSIBILITY
7. IMPROVED FOUNDATION STABILITY
8. MOTOR AND GEARS BUILT BY ONE MANUFACTURER
9. DESIGNED AND APPLIED TO A.G.M.A. STANDARDS

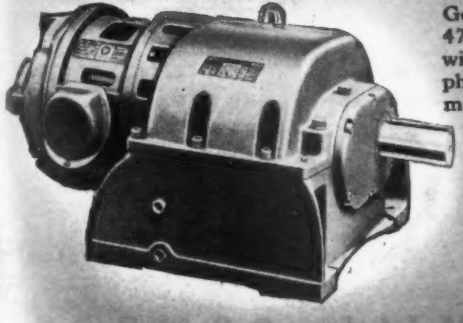
There is a Westinghouse speed reduction unit for most applications



TYPE A GEARMOTOR—Single-reduction unit. Gear ratios 1.22, 1.50, 1.84, 2.24, 2.73, 3.37, 4.17, 5.00, 6.25. Available with single-phase, polyphase, and direct current motors.



TYPE C GEARMOTOR—Double-reduction unit. Gear ratios: 7.61, 9.21, 11.3, 14.0, 17.5, 20.8, 25.7. Available with single-phase, polyphase, and direct current motors.



TYPE E GEARMOTOR—Double-reduction unit. Gear ratios: 31.2, 38.9, 47.3, 52.7, 58.3. Available with single-phase, polyphase, and direct current motors.

In the last few years, machine drives have taken a terrific peak-load punishment. So it's natural that reconversion will require many replacements with modern, economical drives.

When drives require speed reduction... and four out of five do... use a gearmotor. Specifying gearmotors simplifies ordering and delivery... saves installation expense because the complete drive is in one "package".

Westinghouse offers a complete line of gearmotors for speed-reduction drives up to 75 hp, and a complete line of similar speed reducing units for drives up to 1000 hp. Call your Westinghouse Office for information, or write Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa.

J-07229

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Gearmotors

If you paint Zinc-Coated products

CHECK THESE 6 POINTS

Here are six questions and answers about paint characteristics on two different zinc-coated sheet steels. Checking them may help save you time and money.

			Ordinary Galvanized Steel	Armco Galvanized Paintgrip
✓	1	Does it take paint without pre-treatments?	No	Yes
✓	2	Is the full-weight zinc coating intact?	No*	Yes
✓	3	Is paint "insulated" from the zinc coating?	No	Yes
✓	4	Does the zinc surface rob paint of its oils?	Yes	No
✓	5	Will paint adhere . . . without premature peeling or flaking?	No	Yes
✓	6	Does paint resist scraping or other abrasive action?	No	Yes

*Acid etching, used as a pre-treatment for painting, destroys part of the zinc coating.

THIS TELLS THE STORY OF TRIPLE PROTECTION

Advantages of ARMCO Galvanized PAINTGRIP over ordinary galvanized for all painted products are clearly illustrated in this "peel-off" drawing.

The full-weight galvanized coating is "insulated" from the paint finish by the mill-Bonderized PAINTGRIP surface treatment. On ordinary galvanized there is no "insulation." The zinc robs paint of its oils, causes it to become brittle.

Actually it costs less to use ARMCO PAINTGRIP sheets than to use ordinary galvanized and acid-etch before painting. And PAINTGRIP keeps the paint on your products looking better longer.

Write for the free ARMCO PAINTGRIP booklet. It gives complete information on fabricating, finishing and applications of this steel. Just address The American Rolling Mill Company, 2471 Curtis Street, Middletown, Ohio.

EXPORT: THE ARMCO INTERNATIONAL CORP.

GALVANIZED PAINTGRIP ARMCO STEEL

Special-Purpose Sheet Steels

THE AMERICAN ROLLING MILL COMPANY

GRATON & KNIGHT ENGINEERS PRESENT

PACKINGS POINTERS No. 13

Handy, file-size folders of each article in the series, including additional information, are available, free. Write to Packings Department, 321 Franklin St., Graton & Knight Company, Worcester 4, Mass.

Supports for U Packings

It is a comparatively simple matter to use a metal pedestal ring on any U packing application. Figure 1 shows the type of pedestal ring (R) most commonly used and generally accepted as conventional.

The height (C) of the ring R is such that when gland G is tight at E, the space allowed for the packing between the gland and the top of the pedestal ring will be 1/64" less than the thickness of the packing material. This slight pinch on the base of the U packing holds it firmly in place and prevents any tendency to turn over or elongate while in service. The amount of pinch on the base or bottom of the U may be varied for different thicknesses of packings, but shall be only enough to hold the packing firmly, not crush it.

Clearance at M between the bevel on the pedestal ring and the lip of the packing should be 1/16 to 1/8 inch in order to allow the medium free access to the inside of the packing so that the packing will act as a mechanical seal. Thus, the height H' will be H–T–1/16 to 1/8 inch.

The dimension at N should be less than that of the groove in the packing. The proper formula should be the cross-section (W) of the base of the pedestal ring (which is also the width of the recess) minus 2.5 times the thickness of the packing material.

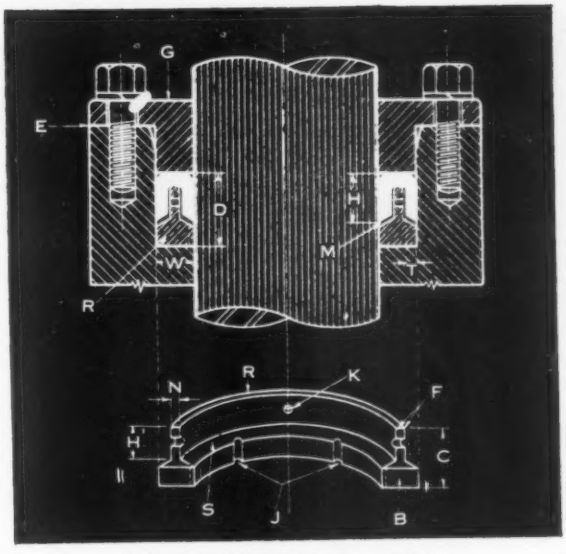


Fig. 1 PEDESTAL RING

Breaking the sharp corners at F will avoid cutting the packing.

The outside diameter of the base B of the pedestal ring should be a slide fit in the recess. The shape of the shoulder S is unimportant so long as it does not interfere with the top of the packing.

Vertical grooves at J allow the medium free access to the inside of the packing and the holes at K allow it to reach the outside leg of the packing. Instead of the grooves, the inside of the base of the pedestal ring can be enlarged as shown by the dotted lines.

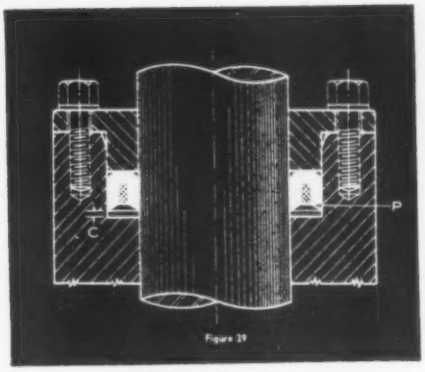


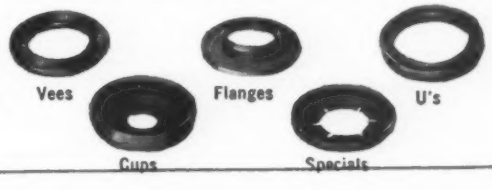
Fig. 2 FLAX FILLER

Although the use of a metal pedestal or throat ring is the best practice, there are many U packings installed without pedestal rings. The U packing almost invariably requires some type of filler. Braided flax, twisted hemp, hard tucks, laminated fabric and rubber, leather and wood have all been utilized. Figure 2 shows a typical flax-filled U packing installation. The only requirement of this type of flexible filler is that it be compressible, swell slightly rather than shrink in the medium, and suitably serve to keep the inside and outside walls of the U packing P in sealing contact with the packing recess and ram.

Clearance at C between the bottom of recess and the lip of the packing should be 1/16 to 1/8 inch on the larger installations, but in no case should the lip of U packing be allowed to hit the bottom of the recess.

SPARTAN LEATHER PACKINGS

Graton & Knight's SPARTAN has highest resistance to abrasion and heat (withstands boil test), is unaffected by common pressure mediums, and will not dry out hard and brittle. It also has exceptional tear and tensile strength. When your design reaches the "packings point"—or when packings trouble occurs — call on G&K engineers.



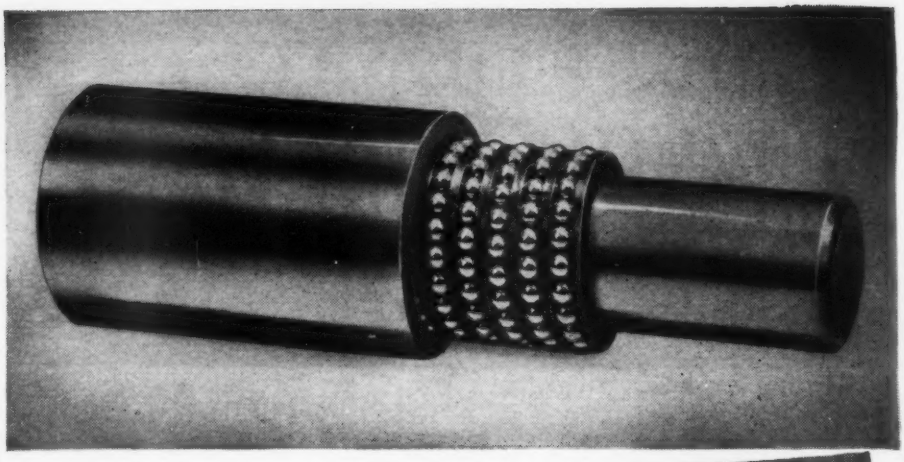
See Graton & Knight Insert in SWEET's File for Product Designers

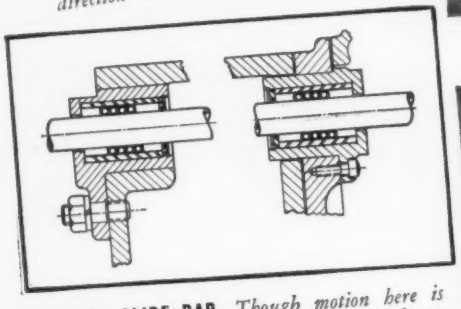
GRATON AND KNIGHT

Spartan Engineered Packings

Leather and synthetic rubber packings manufactured and engineered by the world's largest manufacturer of industrial leather products

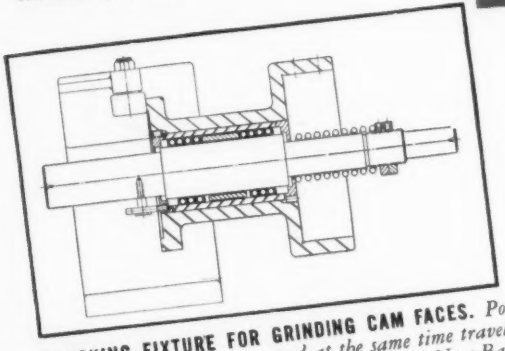
VALVE SEAT GRINDER. *New Ball Reciprocating Bearing here carries spindle, which not only revolves but also travels in axial direction to relieve contact intermittently.*



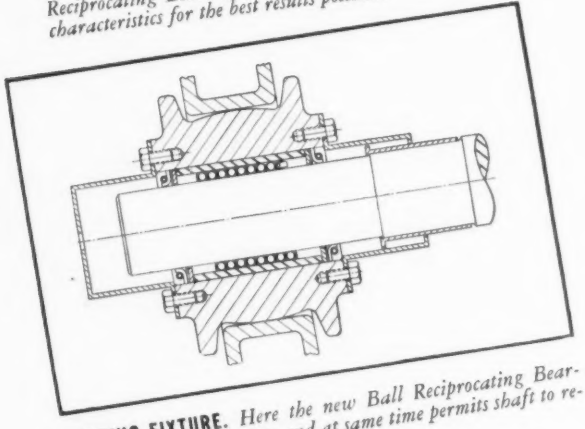


GOVERNOR SLIDE BAR. *Though motion here is axial only, freedom from drag is required and new Ball Reciprocating Bearing accomplishes this with outstanding efficiency.*

RECIPROCATING BEARING FINDS WIDE APPLICATION



CHUCKING FIXTURE FOR GRINDING CAM FACES. *Pot chuck at the right revolves and at the same time travels horizontally to perform a cam profiling action. New Ball Reciprocating Bearing provides the required application characteristics for the best results possible.*



WELDING FIXTURE. *Here the new Ball Reciprocating Bearing allows wheel to rotate and at same time permits shaft to reciprocate back and forth as required.*

Because it allows free axial as well as radial motion . . : combined with unusually high anti-friction capacity . . . Torrington's new Ball Reciprocating Bearing is finding wide use wherever ball bearing anti-friction qualities are desired in rotation, reciprocation, oscillation or combinations thereof.

Designed by the engineers of Torrington's Bantam Bearings Division, this modern and efficient unit employs a helix to separate the balls and retain them. This permits the use of *approximately twice as many balls* as the conventional sleeve type retainer, with corresponding increase in anti-friction efficiency. In addition, the unit has the traditional Torrington advantages of compactness, simplicity in design, and built-in long life.

Shown on this page are just a few of the many applications where the new bearing is helping modern equipment do a better job. Would you like to know how it can improve the efficiency of *your* equipment? Write for a copy of Bulletin 105, which gives full engineering and application data. And feel free to bring your anti-friction problems, routine or unusual, to Torrington's Bantam Bearings Division.

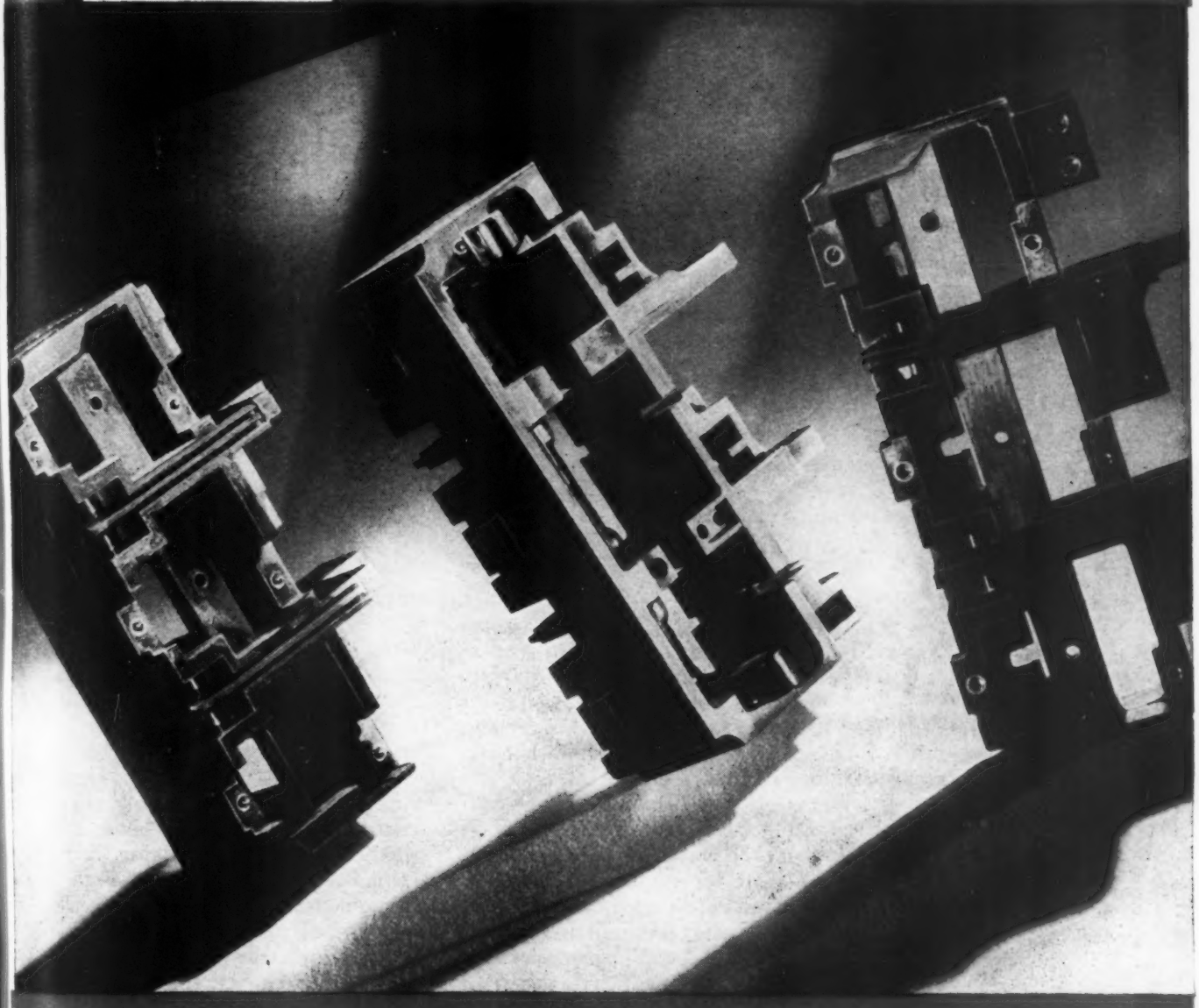
THE TORRINGTON COMPANY · BANTAM BEARINGS DIVISION
SOUTH BEND 21, INDIANA

TORRINGTON BEARINGS

STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL

Another Plastic Success Story . . .

This electrical switch gear section was brought to TECH-ART by a leading manufacturer of electrical equipment. Even in simplified form, the design required more than 300 molded surfaces, with fillets, chamfers, inserts and sections of varying thickness to complicate the mold. Made to fit in with an assembly of other plastic parts, each of its 300 surfaces had to be molded to precise tolerances. TECH-ART engineers produced the mold design—TECH-ART mold builders made the mold—and the accurate pieces that resulted are now another chapter in Plastic Success Stories by TECH-ART.



An Electrifying Idea . . . Molded in PLASTICS

Fitting this complicated piece into the electrical industry illustrates an additional ability of TECH-ART engineering—not only to contribute sound engineering judgment where it is possible to simplify a new design idea, but to translate accurately those ideas which *cannot* be readily simplified. TECH-ART engineers never hesitate to follow a necessary complex design, because TECH-ART mold builders have the skill and experience to reproduce complex patterns with precision accuracy in every detail. And once the finished mold is turned over to production, TECH-ART's wide molding facilities give full assurance that your finished product will be just what you envisioned in dimensional tolerances, physical appearance, and serviceability.

TECHNICAL NOTES— *Because of its complex nature, this piece had to be produced on a compression-transfer mold. Plastic used is a high-dielectric material, providing the required electrical characteristic.*

36th Ave. and 41st Street • LONG ISLAND CITY, N. Y. • Tel. AStoria 8-6050-1

SUCCESSORS TO BOONTON RUBBER MANUFACTURING COMPANY

PIONEER PLASTIC MOLDERS . . . Established 1891

TECH-ART PLASTICS COMPANY

"I Finish More Work by Noon with AMERICAN PHILLIPS SCREWS THAN I DID IN A WHOLE DAY WITH SLOTTED SCREWS!"

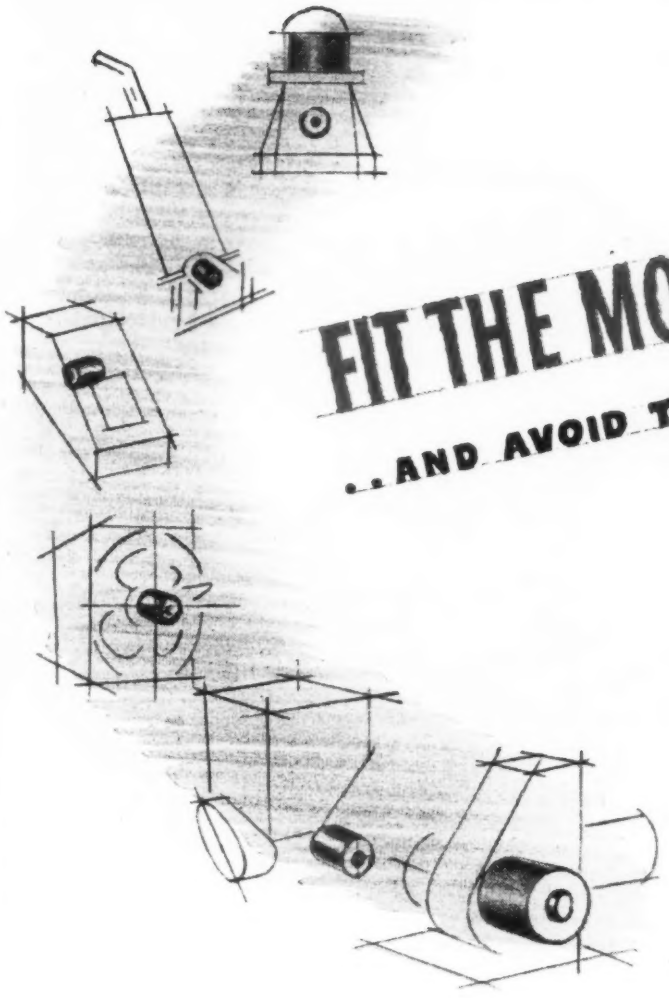
50% FASTER . . . that's the average speed-increase wherever modern American Phillips Screws replace outdated slotted screws. And that's because American Phillips Screws prevent driver-slippage, which means power drivers can be used on any job. So these straight-driving, fumbleproof screws take the brakes off your workers' hands, and the strain off their nerves and muscles. Self-confidence and pride in work is built up . . . and so is output and product quality, for there's no more scarred work or burred, broken screw heads. Time-savings alone are enough to make American Phillips Screws least costly to use on any assembly job in small shop or big plant. But there's another saving that comes from American's own system of quality control and individual 3-point inspection that give you higher "perfection-percentage" in every order. Try American Phillips Screws yourself . . . and see what happens to what you thought were *fixed costs!*

AMERICAN SCREW COMPANY, PROVIDENCE 1, RHODE ISLAND

Chicago 11: **589 E. Illinois Street** *Detroit 2:* **502 Stephenson Building**

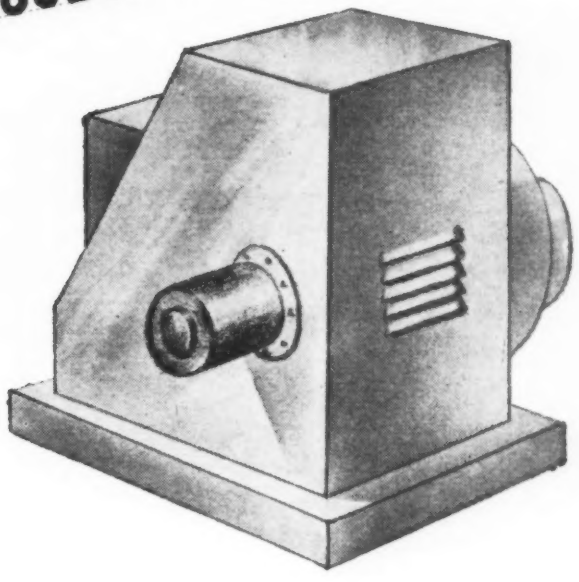
PUT THE SCREWS ON THE JAPS . . . BUY WAR BONDS

AMERICAN PHILLIPS *Screws*



FIT THE MOTOR IN YOUR PLANS

..AND AVOID TROUBLE IN PRODUCTION!



ASK A WESTINGHOUSE APPLICATION ENGINEER

NOW . . . BEFORE YOU "FREEZE" DESIGN

After your appliance is ready for production is a poor time to apply the motor. Do it while your designs are still in the planning stage. Double check to make certain that you have the right motor for the job. A minor change now may enable you to use an existing design, and avoid the extra engineering of a "special".

Westinghouse standardized motor designs offer many advantages, such as lower costs, faster deliveries, speedier production of appliances, lower inventory stock and simplified servicing.

Westinghouse engineering has resulted in many extra features built into standard motors for specialized service requirements. The service of Westinghouse application engineers is available at any time to help you meet your problems. Simply call the nearest office, or write Westinghouse Electric Corporation, Lima, Ohio. J-03228

Westinghouse

SMALL MOTOR DIVISION

MOTOR EXCHANGE PLAN PROVIDES

REPLACEMENT SERVICE IN 24 HOURS OR LESS

ANYWHERE IN THE UNITED STATES

Westinghouse Motor Exchange points in all principal cities can service most Westinghouse small motors of standard sizes in 24 hours, or less, anywhere in the United States. This service gives the appliance user an efficient, factory-rebuilt replacement motor in exchange for his old motor at a low, flat cost. Your nearest Westinghouse office will give you full details. Ask for bulletin B-3336.

WESTINGHOUSE

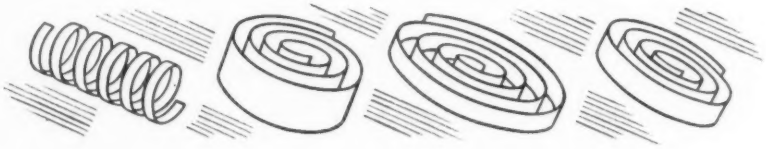
It's always *"springtime"* in your automatic toaster

WHEN you set your toaster for light, dark, or medium, a *steel spring* times it for the shade of brown you like.

Many of these springs are made from special steels developed here at Athenia . . . steels engineered to meet rigid specifications. Smoothly polished surface is one important requirement so each layer of the spring may slide easily over the other. High elasticity is necessary to assure long life and freedom from permanent distortion. Tensile strength helps prevent cracking from over compression. And uniformity of structure is essential for even pull and accuracy of timing.

And for clocks, typewriter carriages, fishing reels, mark-time switches, and many other requirements, Athenia is producing the *precise spring for the job,* either in the form of wound springs or steel strip.

Providing a combination of properties to meet particular requirements has been the work of Athenia for more than 30 years. If you have a precision steel problem that involves stock in widths of 1/16" to 6½", thicknesses of .0015 to .062, annealed, cold-rolled, tempered or tempered polished and colored, try Athenia personalized service.



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The ATHENIA STEEL Company
DIVISION OF NATIONAL-STANDARD

Buy and Keep War Bonds and Stamps

Divisions of National-Standard Company

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Clifton, N. J.
COLD ROLLED, HIGH-CARBON SPRING STEEL

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WORCESTER WIRE WORKS
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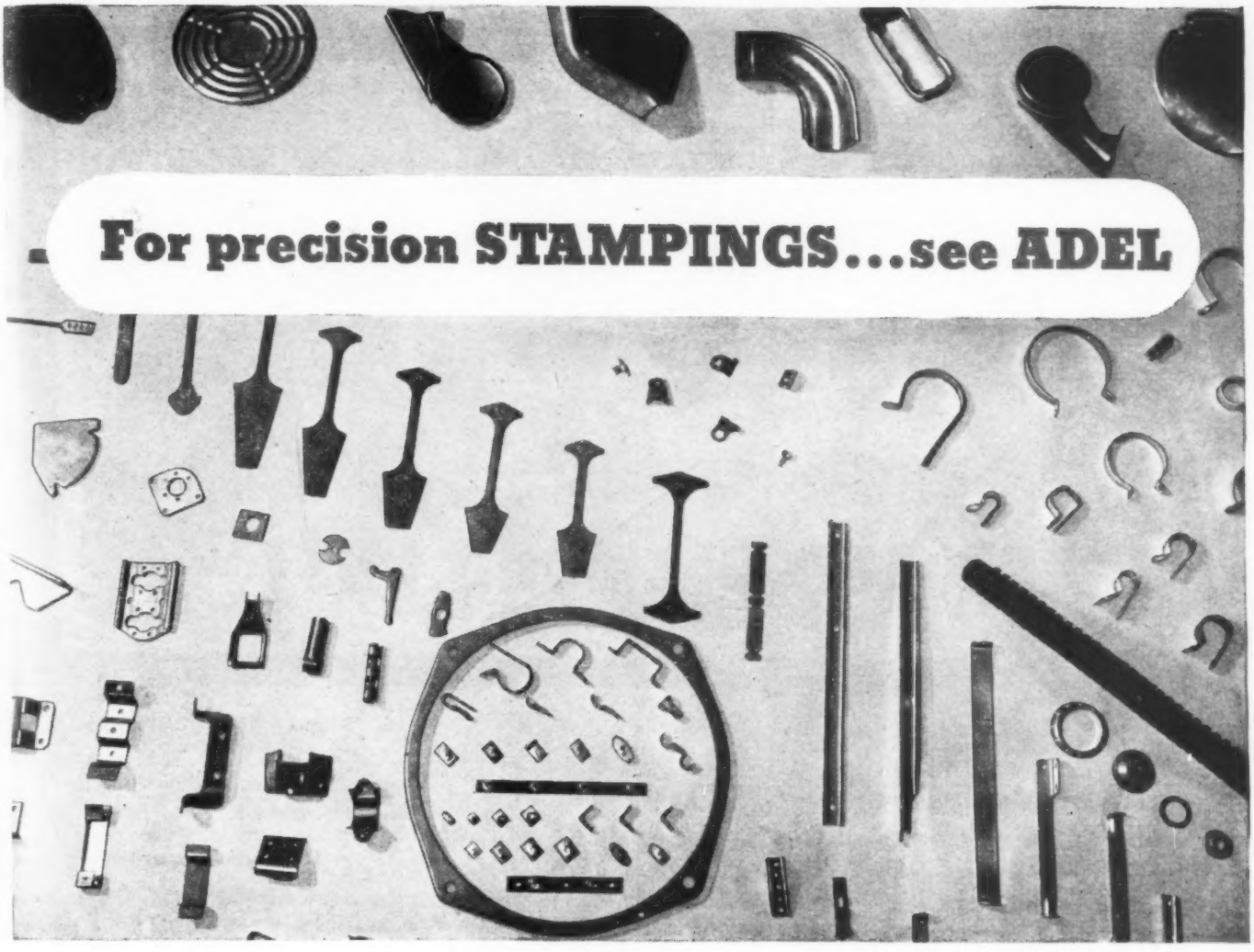
ROUND STEEL WIRE, SMALL SIZES

WAGNER LITHO MACHINERY CO.
Hoboken, N. J.
LITHOGRAPHING AND SPECIAL MACHINERY

For precision STAMPINGS...see ADEL



Just furnish the blueprints—and forget it. The job can be tooled, precision-stamped to close tolerances, heat treated, plated—and even assembled—with ADEL techniques which have been war improved to such production speed that your own product-assembly will move at a faster pace because of ADEL's all-around quick stamping service.

ADEL's batteries of punch presses (range up to 110 tons), and ribbon-forming machines have turned out over 250 million aircraft parts. Use these facilities, and ADEL *Design Simplicity* Engineering to tool, fabricate, process and assemble your parts all in one shop. ADEL plants are on either side of the country to provide speedy service to industry all over the U.S.A.

For stamping runs that are really fast, call an ADEL engineer at the office nearest you. It will be the first and only step you'll have to take to solve your stamping problems. *Write Dept. F.*

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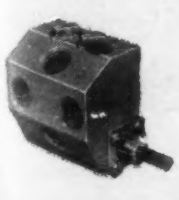
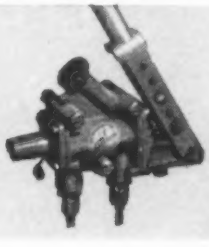


PRODUCTS OF *Design Simplicity* AND *Dependability*

The Aircraft and Transportation Division of ADEL manufactures precision controls for planes, boats, tanks, armament equipment. *Left:* ADEL "Mighty Midget" 4-way hydraulic selector valve. *Center:* ADEL Series "K" Fluid metering pump—outputs from .05 to 200 G.P.H. *Right:* ADEL *ISOdraulic remote control, remains syncronized from −65°F. to +160°F. *Trade Mark



DUREZ AND DIAMOND DUST

The importance of diamond dust abrasive wheels to the war effort cannot be overstated. For cutting such items as tungsten carbide or synthetic sapphires required in the vital production of precision bearings, they have no equal. Among the leaders in this highly specialized field is the George A Greenlee Company, producers of the efficient grinding wheels illustrated above. These wheels are molded from a Durez phenolic compound, a Durez bonding resin and diamond dust.

Until recently, it was common practice in the manufacturing of grinding wheels to use a steel body or hub around which was formed the grinding rim. Because this rim contained costly diamond dust, this method of manufacture seemed essential in order to hold to a minimum specific dimension.

Plastic Hub

When some manufacturers attempted to change over to a compression-molded plastic hub, the problem of maintaining this specific thickness dimension of the rim proved to be the greatest obstacle. However, the success with which the George A. Greenlee Company engineers overcame this stumbling block is evident in the above-illustrated diamond dust wheels now being produced by them.

The hub is first preformed of a high-impact Durez molding compound. In conjuction with this, the grinding rim of diamond dust, filler, and a Durez phenolic resin bonding agent is also preformed. Then the two preforms are molded under heat and pressure until they become a homogeneous unit. The problem of holding the rim to the desired thickness was solved by an ingenious molding method developed by Greenlee engineers.

Unusual Versatility

The unusual versatility of Durez phenolic plastics and resins has resulted in their ever increasing use throughout practically all fields of industry. Such properties as impact strength, dielectric strength, and heat, moisture, and chemical resistance, render them invaluable to the design engineer.

Perhaps you have a plastic material problem. If so, we suggest that you take advantage of the quarter century's experience which makes up the background of Durez technicians. The benefits which this experience and a tremendous accumulation of proved data can provide are available at all times towards helping you find the plastic that fits your job. Durez Plastics & Chemicals, Inc., 307 Walck Rd., N. Tonawanda, N.Y.

DUREZ

PHENOLIC RESINS

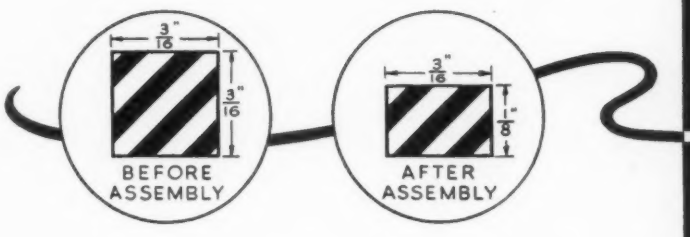
MOLDING COMPOUNDS

INDUSTRIAL RESINS

OIL SOLUBLE RESINS

PLASTICS THAT FIT THE JOB

TRULY COMPRESSIBLE GASKET



1. Permits rigid metal-to-metal assembly

2. Seals light hydraulic oil at 200° F.

PERMANENT FLANGE PRESSURE of over 300 lbs. per square inch is maintained by this Armstrong's Cork-and-Synthetic-Rubber Gasket, compressed 33-1/3%. No lateral flow occurs during compression.

TWO successive problems confronted an equipment manufacturer who had to seal light hydraulic oil at 200° F. and, at the same time, maintain an absolutely rigid assembly.

The conventional type of assembly—a gasket bolted between flat flanged surfaces—did not work. No matter how tightly the bolts were pulled down, the joint remained comparatively flexible. A metal-to-metal joint was then designed, using a 3/16" x 3/16" section non-compressible gasket in a 1/4" x 1/8" groove. This, too, proved impractical. Assembly was difficult, and excessive strain caused the non-compressible gasket to age rapidly.

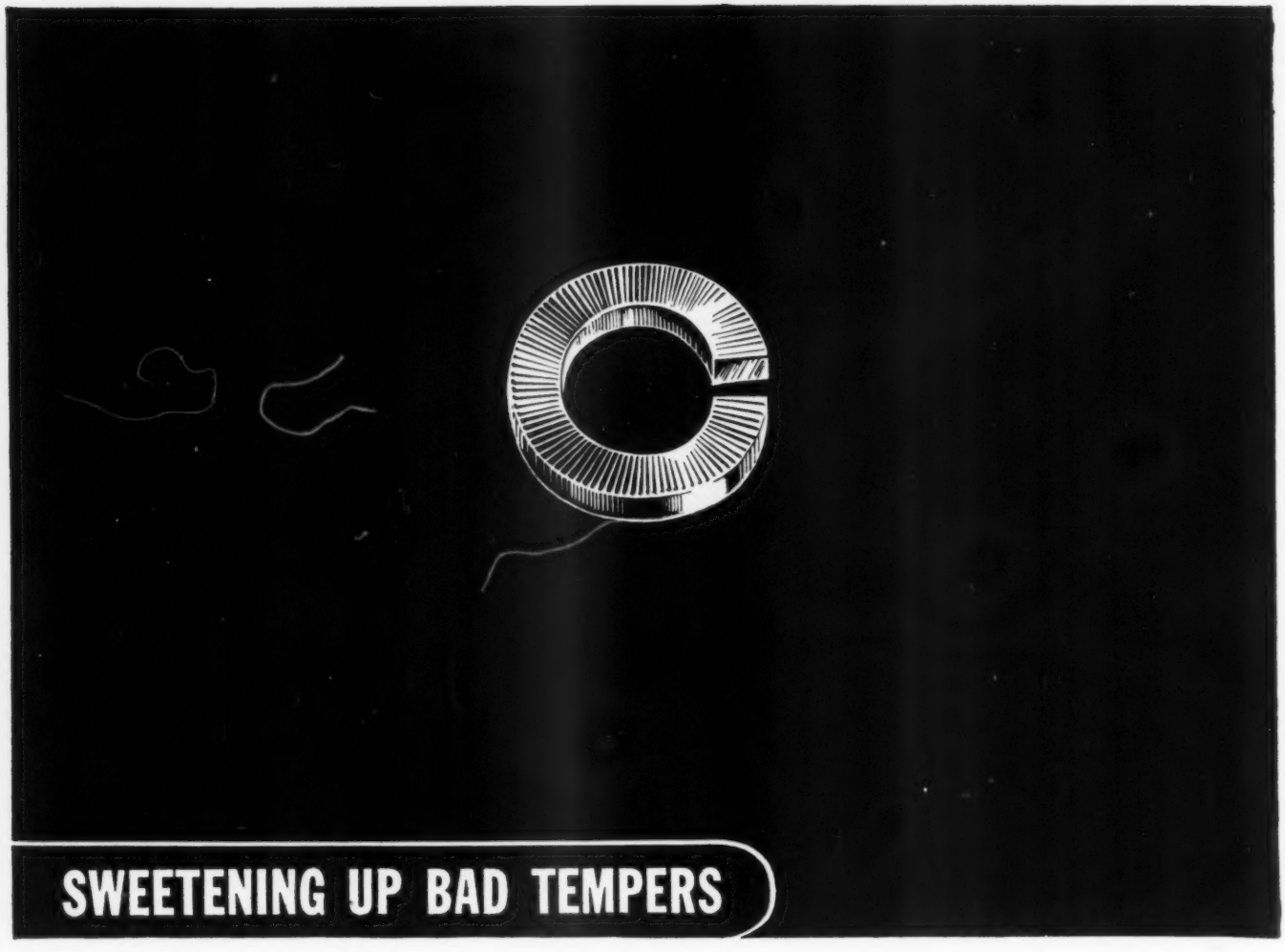
The problem was completely solved with one of Armstrong's truly compressible cork-and-synthetic-rubber compositions. A 3/16" x 3/16" section gasket was made and compressed one third into a 3/16" x 1/8" groove. There was no side flow with this specialized Armstrong material. Its true compressibility and permanent resilience produced a tight, positive seal . . . permitted the metal-to-metal assembly required for absolute rigidity.

In addition to cork-and-synthetic-rubber compositions, Armstrong offers a variety of other specialized sealing materials. These include cork compositions, synthetic rubber compounds, fiber sheet packings, and rag felt papers. This wide range of materials assures you of getting unbiased recommendations when you consult Armstrong on your sealing problem. Send working drawings and details of your application to us, and we'll submit samples of gaskets to do the most efficient job.

SEND FOR FREE BOOKLET—For descriptions of Armstrong's Sealing Materials, see Sweet's File for Product Designers. Or write for your copy of the free booklet, "Gaskets, Packings, and Seals." Address Armstrong Cork Company, Gaskets and Packings Department, 7107 Arch St., Lancaster, Pa.

ARMSTRONG'S
GASKETS · SEALS · PACKINGS

Cork Compositions • Cork-and-Synthetic-Rubber Compositions
Synthetic Rubber Compounds • Cork-and-Rubber Compositions
Fiber Sheet Packings • Rag Felt Papers • Natural Cork



SWEETENING UP BAD TEMPERS

Another result of industrial cooling

THE Puritans, they say, used ducking stools to cool off bad tempers. Not a bad idea . . .

Take steel lock washers. They have to be tough. To make 'em tough . . . real tough . . . and give 'em a good temper . . . they're heat-treated and then dunked in an oil quench.

But, trouble starts when the quenching oil gets overheated. Too-hot oil results in poorly tempered washers—costly rejects or *dis*satisfied customers.

And that's why G-E comes into the picture with the Evaporative Cooler . . . to keep the quench oil at the proper temperature . . . to assure uniform strength and temper in the finished product.

G-E Evaporative Coolers have a water-economy feature of especial interest in areas where water is scarce or expensive.

For example, the oil to quench ½ ton of steel washers an hour is kept cool with 60 gallons of water per hour. *Conventional methods of cooling this oil would require approximately fifty times as much.* In high-cost-water areas, this single saving will frequently pay for the equipment within a year.

G-E Evaporative Coolers are easy to clean and service . . . greatly reducing maintenance costs where water sources are impure—as most of them are. And in event of interrupted water supply, the unit's water reserve is sufficient to provide continuous cooling—often long enough to repair the stoppage—and prevent a production jam.

You may not be manufacturing lock washers. But the chances are that somewhere in your processing . . . in your plant . . . are applications where G-E's specialized industrial cooling, refrigeration, and air conditioning techniques will help develop better products . . . lower unit costs.

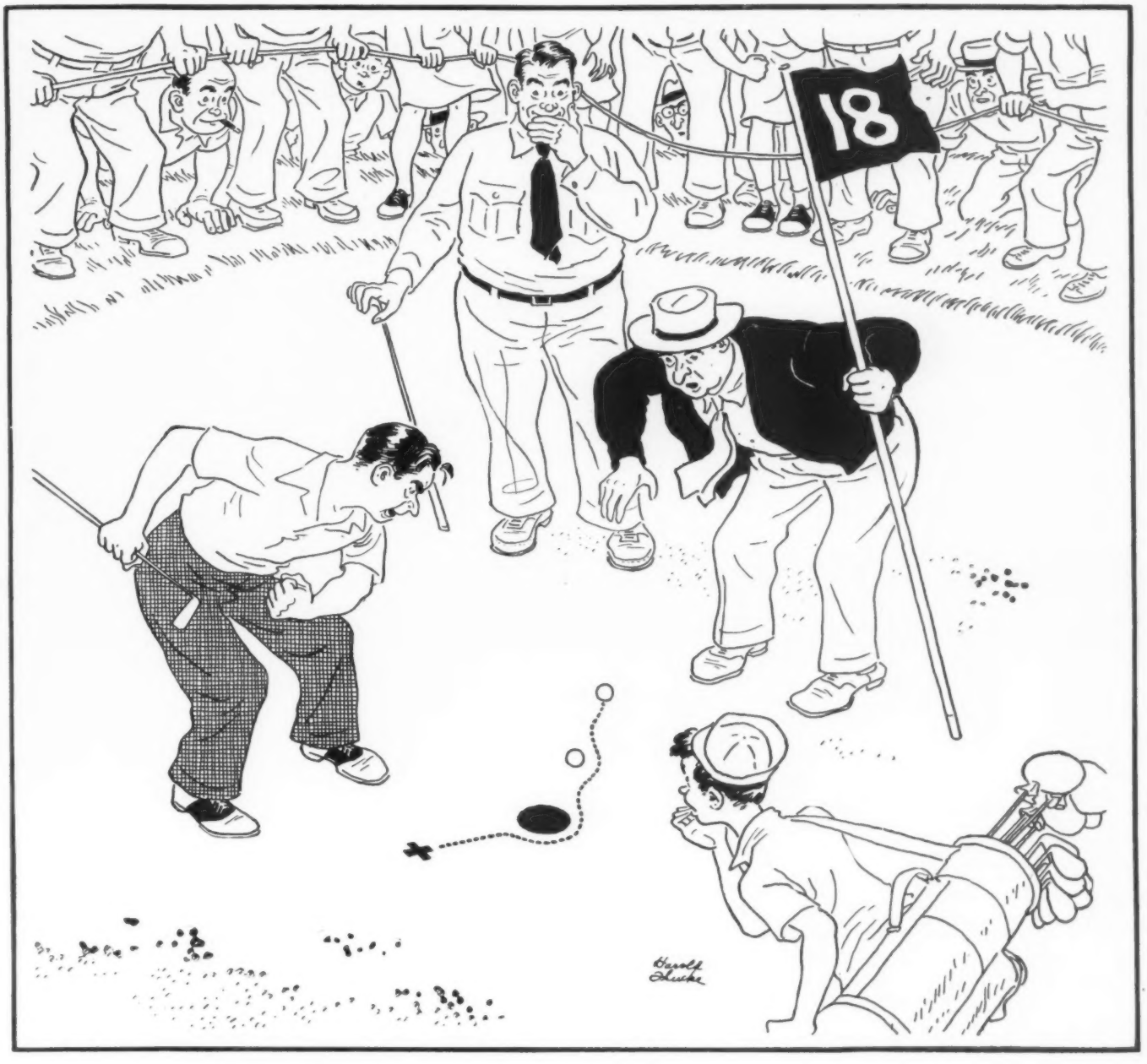
General Electric Company, Air Conditioning Department, Section 5477, Bloomfield, New Jersey.

BUY . . . and hold . . . WAR BONDS

GENERAL ELECTRIC

Industrial Refrigeration

Tune in: The "G-E HOUSE PARTY," every afternoon, Monday through Friday, 4 p. m., E W T, C B S . . . The "G-E ALL-GIRL ORCHESTRA," Sundays, 10 p. m., E W T, N B C . . . "THE WORLD TODAY" News, Monday through Friday, 6:45 p. m., E W T, C B S

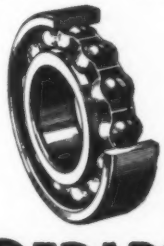


Nothing Rolls Like a Ball . . .

According to the annoyed gentleman above, that's *bad*. According to his opponent, that's *good*.

And, according to Industry, faced with ever-new problems of higher speeds, heavier loads and greater precision, that's the answer to many prayers.

For the *ball* bearing is fundamentally different. It is outstanding for free-rolling, precise location of parts, for simplified design, with low maintenance costs.



In millions of applications, New Departure Ball Bearings are proving their unique fitness for the new scheme of things mechanical.

We know of no other bearing that has as many advantages as the *ball* bearing. Particularly the *ball* bearing backed by New Departure's experience and technical skill.

•

Our 112 page illustrated book "Why Anti-Friction Bearings" is mighty interesting. May we send you a copy?

NEW DEPARTURE
BALL BEARINGS

3373

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN. • Branches in DETROIT • CHICAGO • LOS ANGELES and other principal cities

MOTOR LIFE-SAVER

Continuous overloads, frequently repeated overloads, low line voltage, too frequent starting and stopping, excessive ambient temperature, mechanical failure . . . these are just a few of the causes of motor burnouts.

Yet you can get complete protection against motors overheating and burning out from any cause by buying motors with built-in Klixon Motor Protectors.

These simple, foolproof protectors take into account all the variables that cause motor burnouts and cut the motor "off" the line whenever the motor temperature reaches the danger point. Because they are built into the motor by the motor manufacturer, you get a tested and proved combination of motor and protector.

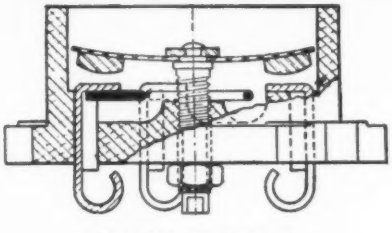
The extra cost for ordering motors with Klixon Protectors is low . . . quickly pays for itself over and over by preventing motor burnouts, reducing factory returns and minimizing motor repairs and replacements.

Specify Klixon Protectors with every motor you buy. They are available in manual or automatic reset types for A. C. motors all sizes; D. C. up to 30 volts. Bulletin PR-112 gives the entire story. Write for a copy.

KLIXON

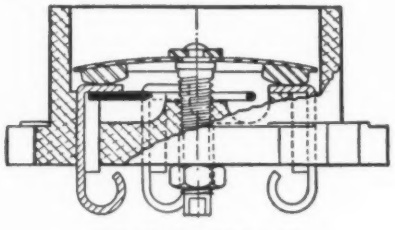
MOTOR PROTECTORS

Here's how it works



CLICK! IT'S OFF!

Should a motor become overheated and dangerously hot, the Klixon Protector snaps the power "off" preventing the motor from burning out.



CLICK! IT'S ON!

When the motor cools to safety, the Klixon Protector snaps the power "on" automatically if the automatic reset is specified . . . or when the reset button is pushed when manual type is specified.

SPENCER THERMOSTAT CO., ATTLEBORO, MASS.

BOSSES

In die castings, tapped bosses form stronger fastenings than integral threaded studs and provide convenient mountings for mating parts.

Strength of bosses is greater because they are usually larger in diameter than studs and because external threads cause a notch effect under shock loads.

Boss holes in *zinc alloy die castings* usually can be cored to tapping size. Tap and chip clearance should be provided below the last thread in blind holes. A chamfer cored at the hole entrance facilitates tapping. Where bosses join the body of the casting, at least a small fillet is desirable.

This drawing of a zinc alloy die casting for the above parking meter illustrates the utility of bosses for attaching mating components. Most of the 17 bosses are cored and 10 are tapped.

DESIGNING FOR DIE CASTING

The above information on bosses was taken from our booklet DESIGNING FOR DIE CASTING. To insure that you will get the most for your die casting dollar, ask us—or your die casting source—for a copy of this booklet.

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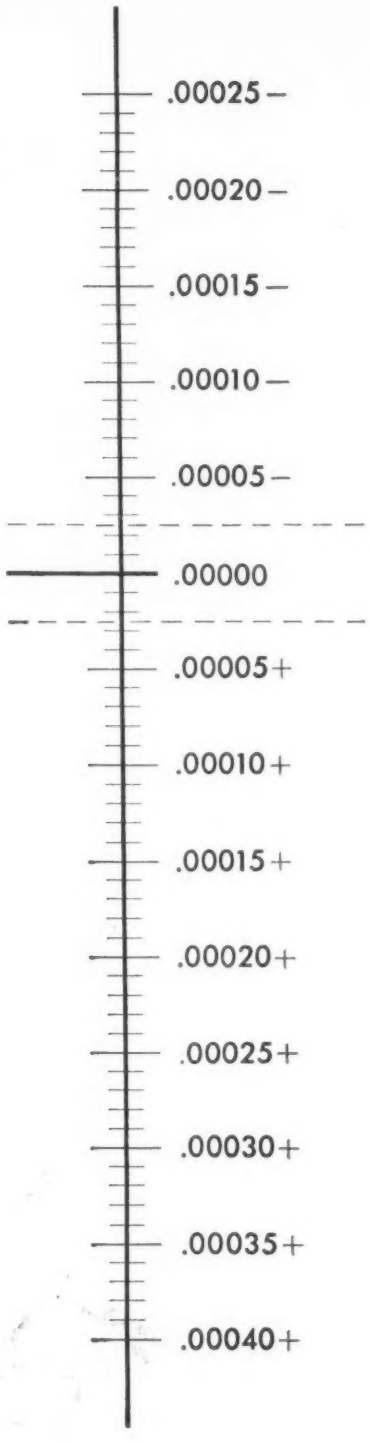

"Ghost" tolerances hover near the zero mark—these are tolerances in "quarter-tenths" and "millionths". To obtain such accuracy requires the proper machines, correct processes, skilled workmen, and gages to show the results.

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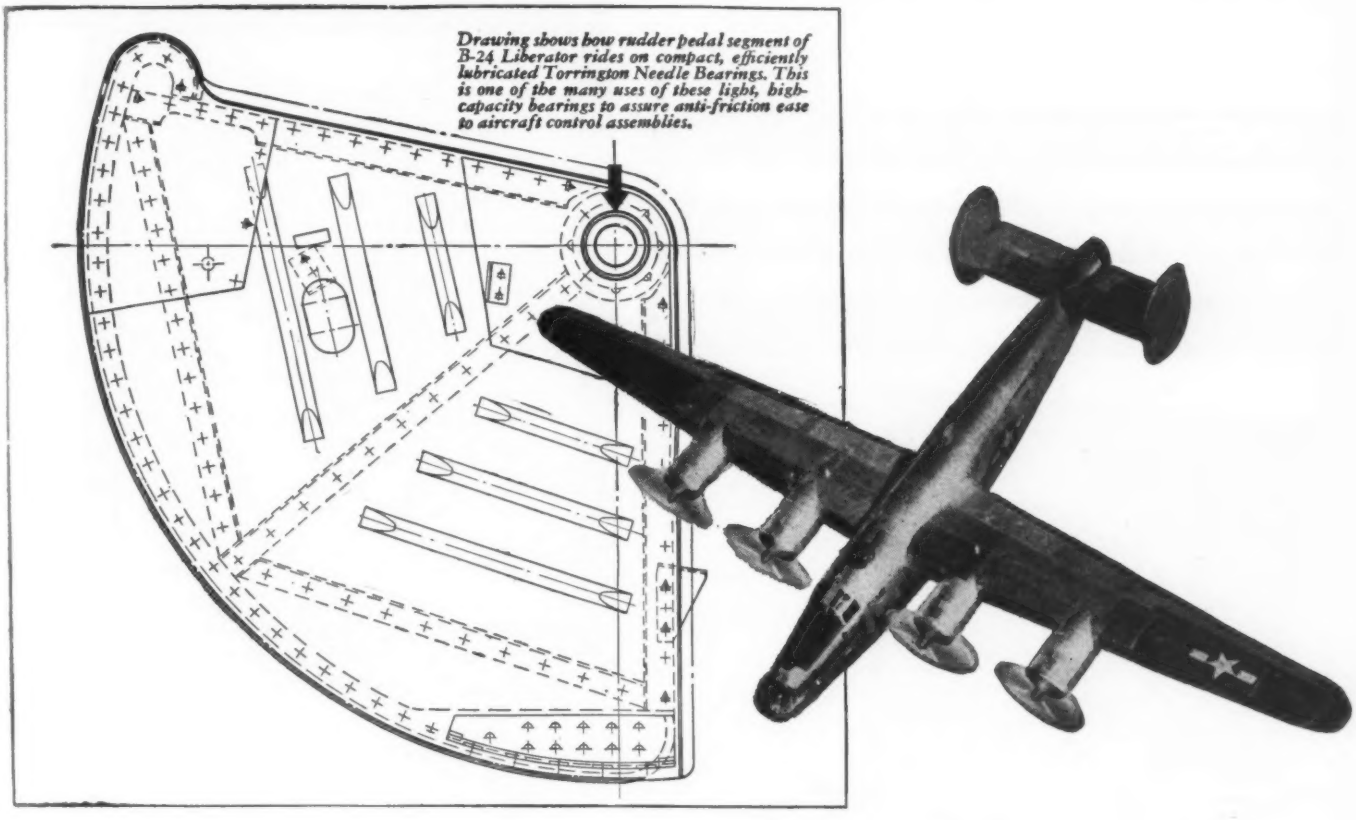
Drawing shows how rudder pedal segment of B-24 Liberator rides on compact, efficiently lubricated Torrington Needle Bearings. This is one of the many uses of these light, high-capacity bearings to assure anti-friction ease to aircraft control assemblies.

Rudder Pedal Segment of B-24 Liberator Rides on Torrington Needle Bearings

It is no surprise that the rudder pedal segment of the mighty B-24 Liberator, rides on light weight, compact Torrington Needle Bearings. For their full complement of small diameter needle rollers packs high capacity into small space, provides an extra margin of safety with the efficiency and reliability that is characteristic of these modern, self-contained anti-friction bearings.

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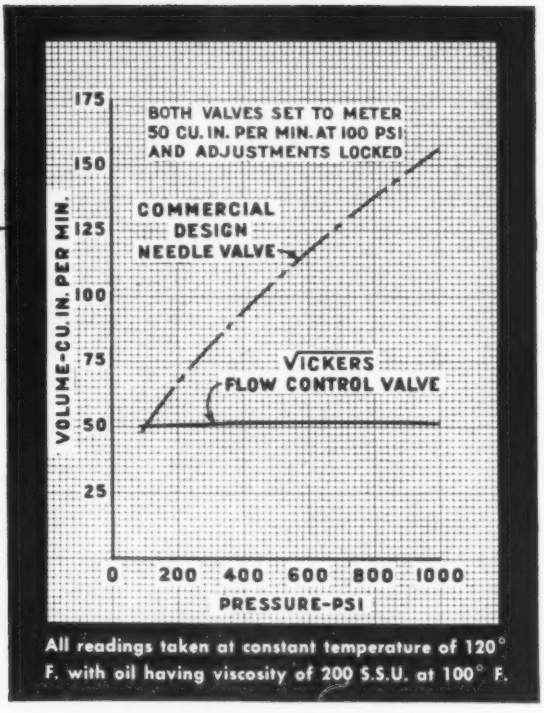

All readings taken at constant temperature of 120° F. with oil having viscosity of 200 S.S.U. at 100° F.

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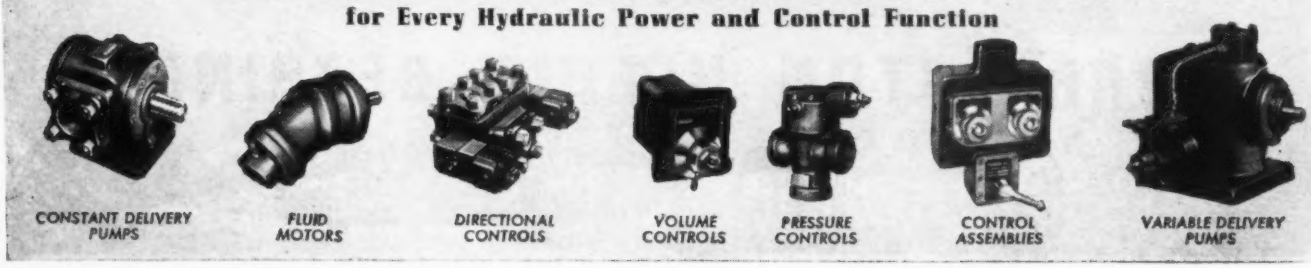


PRODUCT ENGINEERING

JULY, 1945

Technical Research Must Continue To Insure National Security

R. E. LARKIN, *Washington Editor*

Coordinated scientific research for postwar military defense is discussed. The activities of the Wilson and Woodrum committees, and different opinions regarding the form such a program should take, are herein reported.

ONE of the less-heralded but more promising devices for the attainment of the hoped-for "brave new world" is an organization fathered largely by men who have been among the most instrumental in making modern war the fury of destruction it is today. These men would safeguard this "new world" by insuring that the United States shall always be the leader in the ability to wage the most crushing sort of war.

"Research Board for National Security" is the name of this organization which is to serve as the insurance policy for our dream of world peace. It is already in existence, although it is not expected to function in any real sense until the Japanese war has been won. Its 40 members are pre-eminent in their field—scientific research and development. They have been brought together from their normally diverse paths by the conviction that only if that nation which today possesses the greatest single ability to wage war retains and constantly sharpens that ability will it be able henceforth to avoid war.

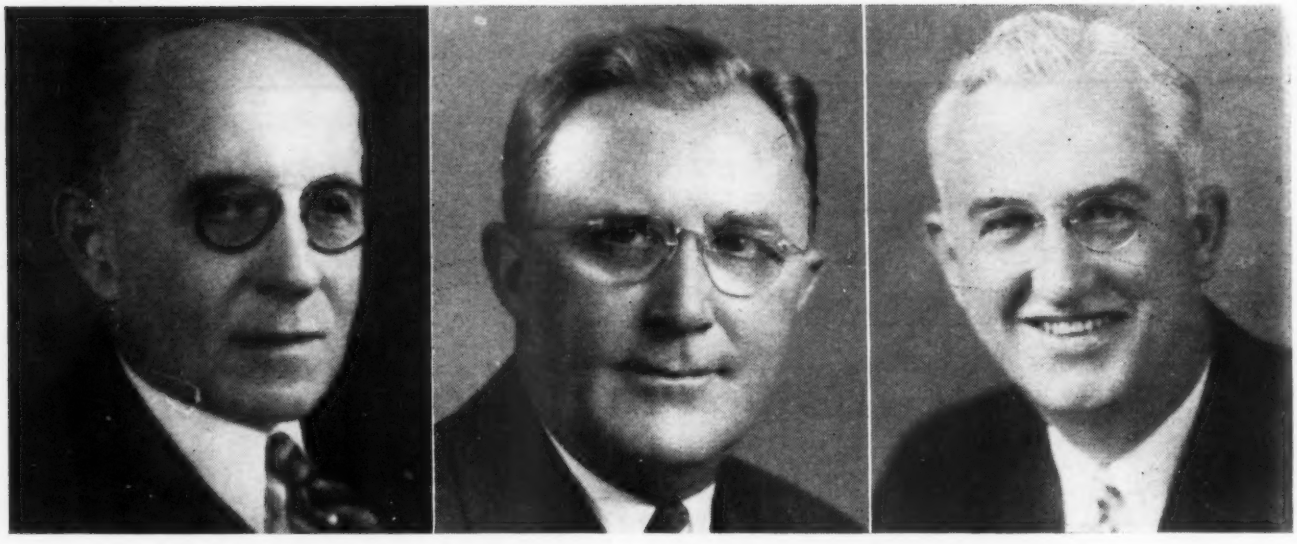
Establishment of such an organization undoubtedly was in the minds of many men a year ago as the United States put the finishing touches on its preparations for the greatest military venture in history—the invasion of Europe. Development of the Board, however, is credited largely to three men, War Secretary Henry L. Stimson, Navy Secretary James Forrestal and Charles E. Wilson, then executive vice-chairman of the War Production Board. They are three of perhaps a dozen men who were most responsible for the transformation of the United States from a totally unprepared nation to the war-making power it is today.

The idea that scientific research along military lines must not dwindle in the United States after peace returns to the world unquestionably was discussed and pondered in numerous official quarters before anything was done regarding it. Indeed, its basic principles are as old as the Civil War, for it was during that conflict that Congress chartered the National Academy of Sciences. The idea was further broadened after the last war, when the National Research Council was formed as an adjunct of the Academy. For various reasons, the idea failed to "take" on either occasion, and the Research Board is, on a much broader and much more thoroughly-thought-out scale, the third attempt to implement basically the same philosophy—"in time of peace, prepare for war." The men whom we charge with the physical security of our peace-loving country subscribe to the eminently logical thesis that the long-range airplane and the controlled missle have so revolutionized warfare that enemies of the United States in the future will be able, unless prevented by our own foresight, to launch a devastating attack upon us from distant places.

Form of Organization Debated

A little incongruously, there is considerable debate and strong feeling as to the exact form the organization ultimately should take. A committee of scientists and military men, organized under Charles E. Wilson by the War and Navy Secretaries, studied the problem of how best to achieve the participation of top-rank civilian scientists in military research after the war pressure has been removed.

History of the Wilson committee is relatively well known. At the request of the Secretaries of War and the Navy, Mr. Wilson, who had expressed considerable interest in the problem of adequate postwar military research and who, as president of the General Electric Company, was intimately acquainted with the value of true scientific research, headed a study committee of 13 members whose duty it was to report on "all aspects of the postwar research and development needs of the Army and



Leaders of postwar military research activity — Left to right: Dr. Frank B. Jewett, president of the National Academy of Sciences; Charles E. Wilson, president of General Electric Company and Rep. Clifton A. Woodrum, chairman of the House Committee on Postwar Military Policy.

Navy, and to recommend a plan or plans for consideration by appropriate authorities."

This committee's report took for granted that "the Army and Navy must continue to carry the major responsibility for such work, especially in times of peace." Based on this concept, and recognizing that the highly-effective Office of Scientific Research and Development is an emergency agency incapable of continued operation in peacetime, the committee reported its belief that the best device for carrying out the above objective is a board composed of civilians and of officers of the Army and the Navy who have important responsibilities in connection with research and development work. To keep such organization from becoming unwieldy and yet to make it truly representative, it recommended a membership of about 40 men, equally divided as to civilian and military membership, its military membership equally divided between the two services. An executive committee of five, dominated three to two by civilians, would "administer and supervise" the board's activities to provide the proper centralized control of so large a group.

The only point on which the Wilson committee was unable to agree was that dealing with the type of organization ultimately to assume responsibility for postwar military research. One faction urged the necessity for an independent government agency which would receive its funds directly from Congress and would thus be co-equal with the military services it was organized to serve. Another group insisted that the postwar military research agency should be subordinate to the National Academy of Sciences, receiving as much money as it required through earmarked items in the Army and Navy appropriation bills. Division in the Wilson committee was close, seven to six, actually, so a double-barreled recommendation was forwarded to Secretaries Stimson and Forrestal.

The Wilson committee report and the concept it espoused when transmitted to ranking officers of the Army and Navy who are concerned with the problem, drew endorsement from each group on all but the matter of organizational form. Virtually without exception, Naval men favored an independent agency, although there was some Navy sentiment that the agency might well be under the aegis of the Academy for a limited period, until the postwar organization of the services has been settled upon. Almost equally without exception, Army officers concerned favored a board under the Academy receiving its funds under earmarked items in the Army and Navy appropriation bills.

Such a plan, obviously, would give the services far greater control over the activities of the board than would a plan whereby the board received funds independently of the services.

Congress Studies Problem

With the submission of the Wilson committee report, the whole problem of how best to provide top-notch postwar scientific coverage for the military services was taken up by Congress. Hearings on the matter were undertaken by the House Select Committee on Postwar Military Policy. Headed by Rep. Clifton A. Woodrum, Virginia Democrat and one of the real leaders of the lower chamber, this committee had been concerning itself with similarly weighty postwar military problems—the proper disposal of military surpluses, peacetime conscription and unification of the Army and Navy. The committee was not authorized to report legislation but merely to study and report on military problems which ultimately would face the Congress.

Lengthy hearings before the Woodrum committee demonstrated the extent of the split between the proponents of an independent agency and those who urged a board under the Academy.

War Undersecretary Robert P. Patterson told the committee that the War Department does not favor an independent agency for the task at present.

Maj. Gen. W. L. Tompkins, head of the War Department's Special Planning Division, urged a fair trial for an Academy board before establishment for an independent agency, and declared that the backing which the Academy could furnish such a board would be imposing; that the honor of serving on this board would be an incentive to our highest scientists. The Academy board, he made it plain, would not exercise control over the Army and Navy in their own research, even though they might advise both services.

Col. Ralph M. Osborne, director of Research and Development for the Army Service Forces, put all seven technical services of ASF on record for an Academy board. His reasons were that the Academy is a non-partisan organization of no small prestige, that the Academy board offers the simplest and most rapid transition from OSRD to the new organization, and that support of the military in obtaining funds would be available to an Academy board.

Rear Admiral J. A. Furer, coordinator of research and development for the

Navy, declared that the Wilson committee's recommendations in his opinion, are "inseparable," and that any organization plan which tends to assure continuity of research funds is to be desired. The independent agency, Adm. Furer felt, probably would facilitate the obtaining of funds.

Capt. Carroll L. Tyler, director of research and development for Naval Ordnance, emphatically favored the independent agency, holding that the Academy's charter is so drawn as to preclude it from doing anything until it is asked to do something by a federal agency. This limitation, he indicated, would reduce the effectiveness of the proposed organization.

Civilian and Military Roles

Dr. Vannevar Bush, director of OSRD and credited by many with having played a leading role in bringing the necessity for postwar scientific research on military problems to the attention of men in a position to take affirmative action, told the committee that from an organizational viewpoint, he believed the board should be organized first under the National Academy, and made independent at a later date. He asserted that this was the only method by which to assure a "partnership" between civilian and military scientists.

The services, Dr. Bush maintained, present two obstacles to successful military research. For one thing, he said, their internal organization fails to give sufficient recognition to the requirements and potentialities of science in war. In addition, their personnel, by training and tradition, fail to appreciate the position research must occupy or the contribution it can make. To remedy this, Dr. Bush presented four points, as follows: First, there must be a person at the top with power both affirmatively to direct the planning of new programs and to integrate existing programs. Second, the position of the technical man in uniform must be improved; also, men in responsible positions should have better technical training. Broad or complex problems of research and development should have a status at staff level. Third, there should be an effective scientific interlinkage between the two services. This does not mean, however, that there should not be parallel programs within the two services. Fourth, there should be some form of partnership between civilian scientists and the military. Although research on military problems and weapons is largely a military matter, it is not entirely so. The job is primarily one for the trained professional scientist and engineer.

In the minds of some public men connected with the problem, there is some feeling that a compelling reason why the Army opposes an independent research organization is that it would have less control over the resulting military research program. Conversely, the Navy, smaller than the Army and normally wary lest it be swallowed by its larger companion, is believed to favor independence for the proposed agency so as to free it as far as possible from any chance of Army domination. Whether these motives have any validity, they are considered by informed persons to be definitely in the picture.

By no means so pronounced as the split between advocates of an independent agency and those who favor an Academy board but still confused is the question as to the exact lines of jurisdiction of whatever postwar military research agency shall be established.

All agree that the agency should not operate laboratory facilities of its own, the general understanding being that whatever agency is established shall conduct its work through contracts with industrial and educational laboratories, or perhaps with government laboratories. All agree further that the proposed agency cannot assume responsibility for national defense, which by statute is placed on the Army and Navy. Thus it is conceded that the services must have final determination of their own jurisdiction.

Scope of Proposed Agency

Most witnesses before the Woodrum committee agreed that the proposed agency would devote itself to "fundamental research" while the services would apply its results to specific military problems. But even here there was no unanimity, and the committee's duties, as defined by numerous witnesses, were vague and ill-defined.

Gen. Tompkins expressed the fear that if the agency were made independent, it might, in order to justify itself, spread to other than military fields for its work. Col. Osborne shared this feeling. Maj. Gen. Oliver P. Echols, assistant chief of air staff, insisted that the large engineering staffs of aircraft manufacturers be maintained until the aviation industries could support them through their volume of business. From the point of view of the Air Forces, he declared, postwar research should provide: 1. Continuation of research on problems of flight by the National Advisory Committee on Aeronautics; 2. Continuation of applied research and development by the AAF; 3. Continuation of fundamental research other than that by NACA through AAF contracts with industry; and 4. A Research Board for National Security under the National Academy.

Adm. Furer expressed the hope that the board would take it upon itself to interest younger scientists in military

The M1 Smoke-drake is seen here covering the landing of supplies during an invasion test off the coast of England.

Signal Corps Photo

A cargo carrier land "Weasel" is shown in use at an Ordnance Depot in France for transportation of supplies.

Official Photograph, U. S. Army Ordnance Dept.

A cargo carrier water "Weasel" slogs its way through a sea of mud at Aberdeen Proving Grounds.

needs, so as to provide an unfailing supply of capable men acquainted with and interested in the needs of the services. He also stated that it was the thought of the Wilson committee that the Research Board for National Security would concern itself mainly with research at long-range, fundamental type, such especially as might not fall under the cognizance of any technical service or bureau of the armed services and would in no way relieve these agencies of responsibility for independent research and development work.

The general agreement with Adm. Furer's premise, however, was diluted to some extent by testimony concerning various methods whereby government fellowships might be made available to attract young scientists, or changes in the Civil Service rules which might be made to guarantee high-class civilian scientists pay and prestige equal to that they could command in private life. While the chances are overwhelming that nothing will come of these ideas, they are indicative of an incomplete comprehension of the type of organization envisioned by the Wilson committee.

Another dissent from the concept of confining the board to fundamental research was voiced by Rear Admiral A. H. Van Keuren, director of the Naval Research staff at Anacostia, D. C.

Adm. Van Keuren argued that civilian scientists now working for the government will be dissatisfied with mere test and development work and an absence of fundamental research as would non-government civilian scientists, and warned that morale of existing government scientific organizations must not be impaired.

President Karl T. Compton, of the Massachusetts Institute of Technology, spelled out his conception of the objectives of the proposed board as follows: Any scientific problem of potentially large importance to national security which is at the moment too speculative or unorthodox to justify its engaging the attention of the regular military establishments, or in which the military personnel are not yet skilled or perhaps even interested; any similar scientific development which may require personnel or facilities which are not available in the military establishments.

"The membership of the research board for national security," Dr. Comp-

ton warned, "must not be static. It must not be allowed to develop into a group of old men who look back to their experiences in World War II."

The layman would be more or less certain that military research suffered the same cuts in the years intervening between World Wars I and II that military appropriations underwent, only perhaps more so. Any such impression, the Woodrum committee developed, is completely erroneous. By the testimony of military men and scientists alike, Congress made only the rarest cuts in peacetime items for military research, and on occasion even appropriated money which had not been asked for. NACA grew and developed into the organization it was at the start of this war under Congressional largesse, and the testimony also showed the blunt statement of admiral after admiral and general after general who conceded that the services themselves—not Congress—had hamstrung military research between wars.

The point offers encouragement for the future of military research after the present war.

Research Board Organized

As the Woodrum hearings drew to a close, Secretaries Forrestal and Stimson asked Dr. F. B. Jewett, president of the National Academy, to organize a Research Board under the Academy in line with the first step of the Wilson committee's recommendation. The board was organized, with an executive committee headed by Dr. Compton directing the membership of 40, of which 20 were civilian scientists, 10 were Navy officers, nine were Army officers and one a civilian consultant to the War Department representing the Army. With Dr. Compton on the Executive Committee were Roger Adams, head of the Chemistry Department at the University of Illinois; A. R. Dochez, professor of Experimental Medicine and Surgery at Columbia University's College of Physicians and Surgeons, Gen. Borden and Adm. Furer.

As this article is written, legislation which is obviously an outgrowth of the Woodrum hearings and indicative of the feelings of at least some members of the Woodrum committee has been introduced by Sen. Harry F. Byrd, Virginia Democrat.

The bill, Senate 825, in its preamble lays down a warning to any future economy-minded Congress that research must, to a measurable degree, be given its head and freed from many ordinary restrictions.

The bill establishes a Research Board for National Security. Membership, which is not to exceed 40, includes the Army and Navy officer charged in each organization with coordination of research, chairman of NACA, and such chiefs of divisions of the War and Navy Department as the Secretary of War and the Secretary of the Navy may recommend, and civilians "approximately equal" to the military representation. Civilians shall be nominated by the President of the National Academy, appointed by the President. First terms shall be of one, two, three and four years, with all terms thereafter of four years duration. Civilian members may be reappointed, but "continuous membership shall not exceed two terms."

The duty of the Board, according to section 2, shall be to formulate programs of scientific research and development relative to problems of national security, to direct and conduct the study of such problems and to advise the Secretary of War and the Secretary of the Navy on the applications of science and technology to national security. The Board shall in no way relieve the Army, Navy or other governmental agencies of their own research and development work.

The bill provides for an annual report and requires that at intervals of three to five years, it shall request the President to appoint a committee to review its activities and submit a report which shall be available to Congress.

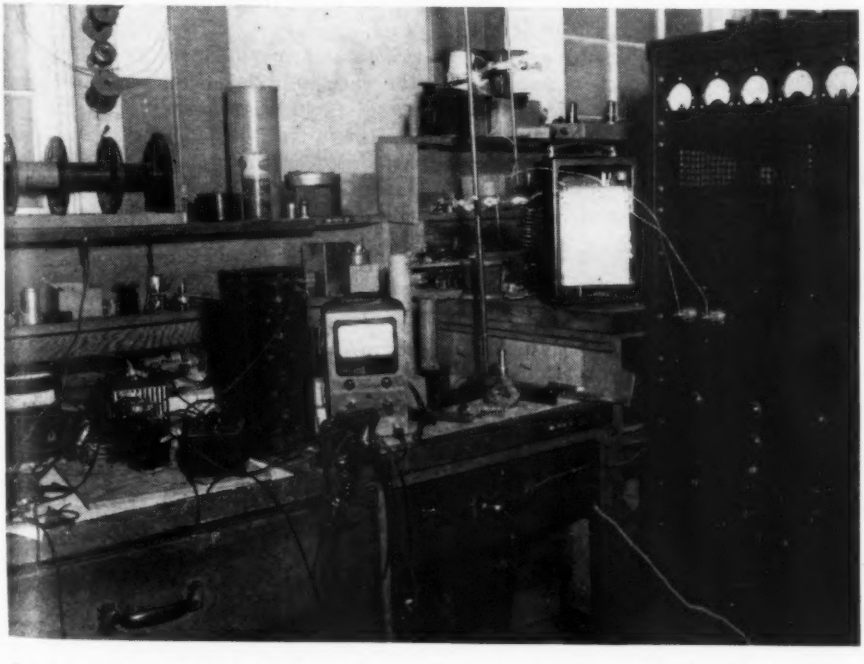
Board members serve without compensation, and the Board may "utilize the services of consulting experts" who also serve without compensation.

Chairman and vice-chairman shall be elected annually from civilian membership, and the chairman shall be chairman of the five-man executive committee, whose membership shall also include the Army and Navy research coordinators and two civilians elected annually. It will be noted that this organization follows that recommended by the Wilson committee.

The Board chairman, with executive committee approval, is given powers sufficiently broad to meet almost any conceivable requirement of a research organization. To further this end, the Board can make use of existing laboratories or transfer funds to other federal agencies; the Board, however, may not operate its own laboratories.

The act authorizes annual appropriations, and provides for a director at $15,000 annually and two assistant directors at $10,000 annually to operate whatever organization the board determines is necessary.

The bill follows the Wilson committee recommendations minutely except that it establishes an independent agency from the start rather than an Academy board first. There probably will be no great rush to enact it since there was no intention that the Research Board function actively before the demise of OSRD, and that demise is not expected to be complete before the end of the Japanese war even though it will start after the German war. The Byrd measure, which undoubtedly is the Woodrum committee's bill, will be available for action until the end of the 79th Congress late in 1946 and can readily be re-introduced in the 80th Congress if necessary. Meanwhile, the Academy board organized some months ago by Dr. Jewett can perform all the functions for which it is called upon.



Products of coordinated research are detecting devices in a Navy laboratory.

Mechanical and Metallurgical Advantages Of Martempering Steel

B. F. SHEPHERD
Chief Metallurgist, Ingersoll-Rand Company

One of the most important recent developments in the field of the heat-treating of steels, martempering, is here explained in a series of graphs and tables which lead from fundamental considerations to the actual performance and the mechanical and metallurgical advantages of the new process.

SALT baths and interrupted quenches have been applied for many years in the heat-treating of steels, but only empirically. When the manner of formation of martensite, the structure to which steel owes its hardness, became understood more fully, the principle of the interrupted quench was developed into a controlled heat-treatment called martempering. Martempering gives greater uniformity and reliability of results and better mechanical and metallurgical properties.

The transformation of austenite to martensite, its completeness and rapidity, hardens the steel. At high temperatures austenite is stable. If the steel is cooled slowly, it transforms to soft pearlite while passing through an elevated temperature range. But if the steel is brought rapidly to a temperature of about 400 to 500 deg. F., the austenite remains stable for a limited period. During the subsequent slow or rapid cooling of the steel to atmospheric temperatures, transformation from austenite to martensite occurs over a definite temperature range. This mechanism of martensite formation is utilized in the martempering process in which steel is quenched from a high temperature, well inside the austenite range, in a salt bath which is above the temperature at which transformation of martensite begins. Then, after temperature equalization, the part is allowed to cool in air. This slow rate of cooling is as effective in promoting martensite formation as any of the conventional quenches. Under these conditions, the new process reduces contraction and transformation stresses to a minimum.

The freedom from internal strains improves mechanical properties and increases impact and fatigue resistance. Martempering thus not only offers a means for producing fully hardened parts without cracking, but also produces parts which are likely to have a better service life. This new process depends on the control of all the factors involved. Quenching practice controls the cooling rate, the cooling rate determines the rate of transformation, and the rate of transformation decides the final structure.

While martempering resembles the much older austempering in which the part is kept in the liquid bath long enough for structural changes to occur, here no structural changes are expected, but rather the retention of the high temperature modification of austenite and the disappearance of thermal gradients.

Understanding of the new process demands a thorough knowledge of hardenability and the mechanism of martensite formation, as will be set forth. The effects of carbon and alloy on hardenability, as determined by the Jominy test, are shown in Table I. In the first three steels carbon is varied, and shows that steels harden relative to the carbon content, even under very slow cooling rates, as is also borne out by Fig. 1. However, carbon alone is at present rarely used as an effective hardening alloy, as it is prone to distort and crack the work. Martempering permits a more effective use of carbon, the cheapest alloying element.

In the last four steels of Table I, the nickel content is varied while all other constituents are constant. Here potential hardness is developed only under fast cooling rates, but with slower cooling, hardness drops less steeply when the alloy content is higher. Therefore, hardness is independent of alloy content at any cooling rate, but the alloy content permits under slower cooling a closer realization of the potential hardness of the steel inherent in its actual carbon content.

In order to obtain a relative value of hardenability Grossman developed the term D.I. value. It denotes the diameter of a bar that would contain 50 percent martensite in the center after a theoretically perfect quench, which cannot be obtained commercially and is therefore called an "Ideal Quench." This theoretical value can be converted to practical figures by using special tables, provided the intensity of the quench is known.

Since hardenability is affected by slight variations in the chemical composition of the steel, the D.I. value for the various carbon contents of a given steel specification makes apparent the spread in the ideal or theoretical hardenability, when plotted so that all alloying elements on the low side of the specification are ranged against all the alloying elements on the high side. Fig.

Table I—Effect of Carbon and Alloy Content Upon Hardenability — Jominy Test

Cooling Rate, Deg. F. per Sec. / Distance from Water-Quenched End, In.								620 / 1/16	190 / 1/8	70 / 1/4	30 / 1/2	10.3 / 1	4.3 / 2
Steel No.	Steel NE	Chemical Analysis C	Mn	Si	Cr	Mo	Ni	Hardness Rockwell "C"					
1	9420	0.18	0.91	0.48	0.42	0.13	0.29	44	39	32	22	16	12
2	9430	0.335	0.90	0.55	0.33	0.19	0.35	52	51	47	31	24	22
3	9440	0.41	0.90	0.57	0.31	0.15	0.37	55	55	53	42	32.5	30
4	8700 Series	0.27	0.90	0.25	0.53	0.27	0.77	50	50	48	41	31	29.5
5		0.27	0.91	0.24	0.53	0.27	1.00	50	50	49	42	33	30
6		0.27	0.92	0.23	0.53	0.26	1.51	50	50	50	45.5	38.5	30.5
7		0.26	0.93	0.23	0.53	0.26	2.04	50.5	50.5	50.3	49.5	45	38

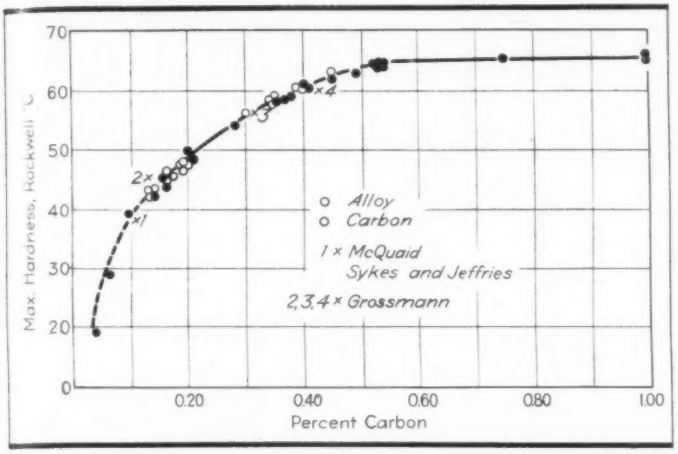
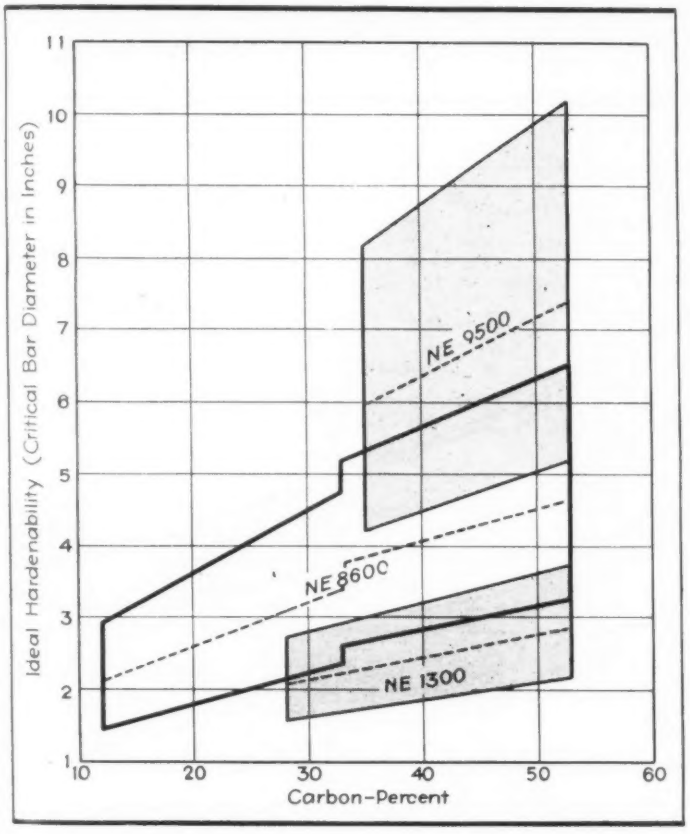


Fig. 1—(Above) Maximum surface hardness obtainable for a given carbon content, as established by McQuaid, Sykes and Jeffries, and by Grossmann.

Fig. 2—(Below) Influence of carbon content on ideal hardenability, calculated from high, low and mean of chemical composition, per list of Dec. 17, 1942.



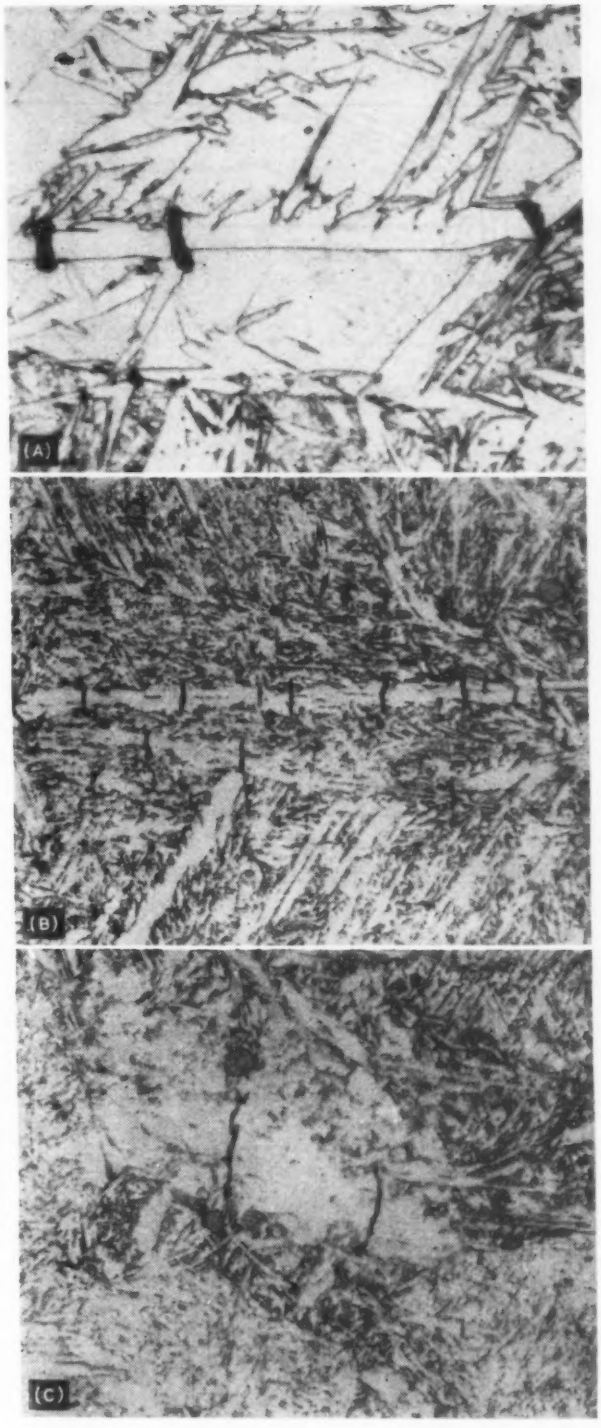


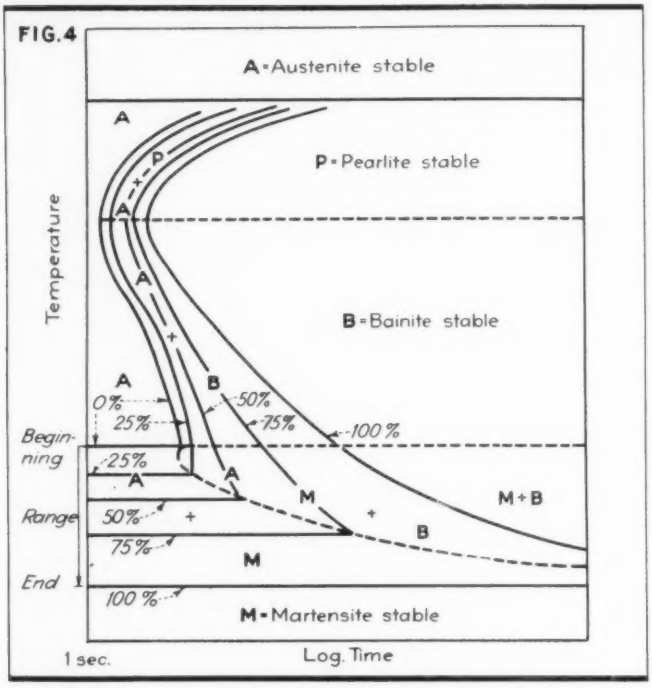
Fig. 3—Microcracks in martensite under 2,500 magnifications. (A) Three microcracks. (B) Martensite needle cracked in 13 places. (C) Inclusions on either side may have helped this martensite needle to crack.

2 shows the considerable divergence of the D.I. values for NE steels 1.300, 8.600 and 9.500, the dotted line corresponding to the average D.I. value. Minimum and not average hardenability should be the criterion when materials are selected on that basis, because they are likely to be supplied with all elements on the low side of the specified range.

As the metallurgical effect of alloys is more pronounced when additions are small and less considerable when additions are large, low-alloy steels are much more sensitive to slight variations in alloy content. For example air-hardening steels, having considerable alloy content, experience practically no change in hardenability within the limits of their specification.

If hardening by conventional methods is adjusted to the minimum specification and the material analyzes according to the maximum, there is a greater tendency for cracking and distortion and high residual strains. Cracks are not always visible and sometimes are internal as shown in Fig. 3. They are micro-cracks in martensite at 2,500 magnification, and they grow rapidly under repeated stressing. Such cracks do not occur in martempering.

Martensite forms from austenite over a range of temperature and not all at one time. As steel approaches lower temperatures in cooling, as shown in Fig. 4, martensite begins to form at the



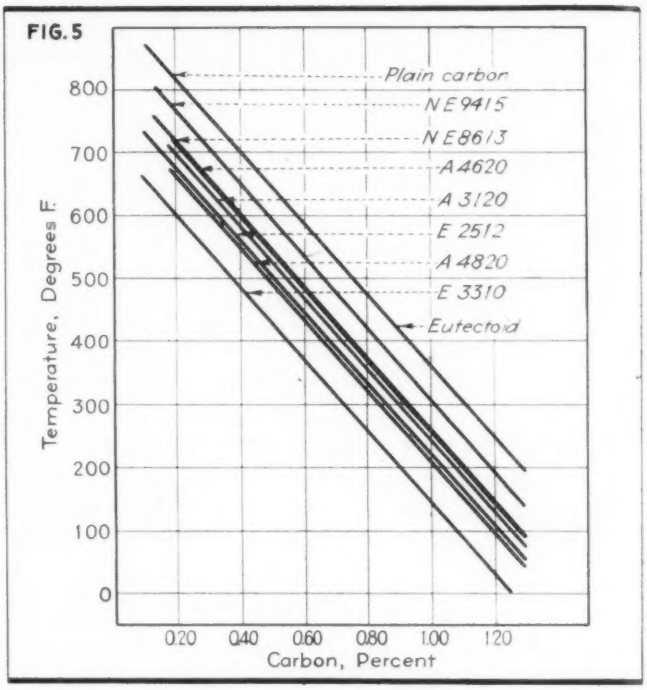


Fig. 4—Modified S-curve diagram (after Cohen). Fig. 5—Influence of carbon and alloy steels upon MS point, calculated on mean of specification according to Payson's formula.

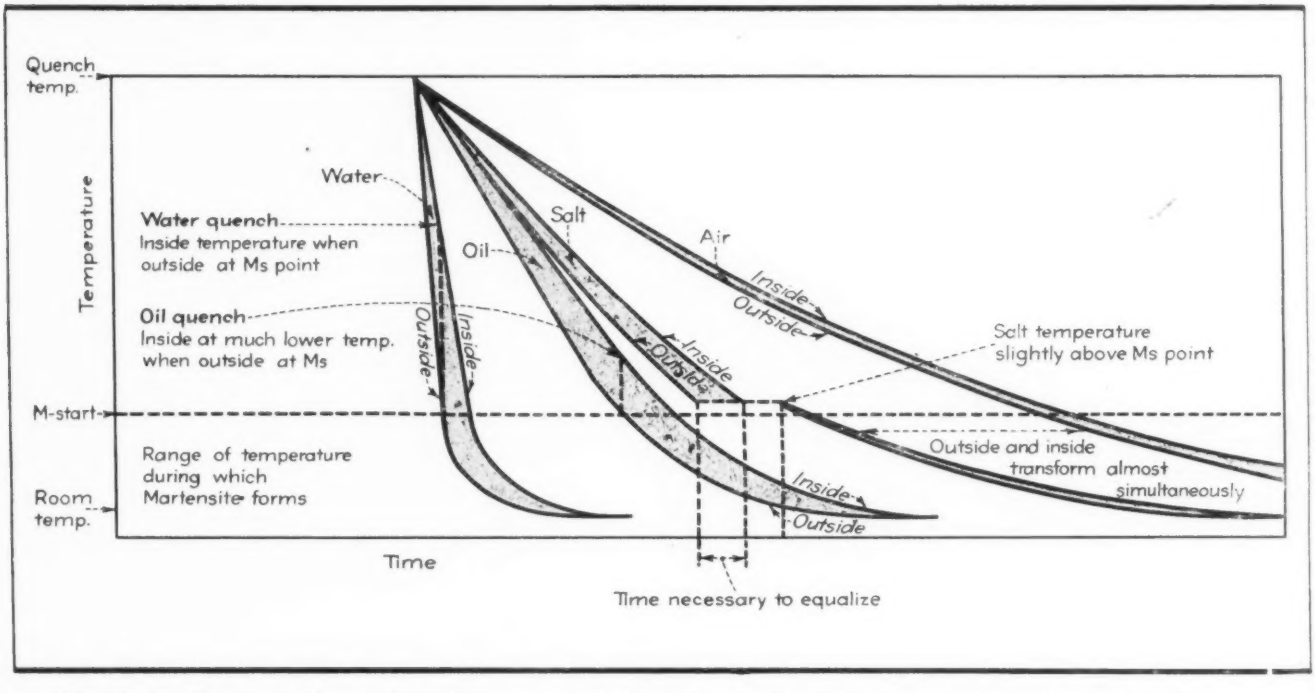


Fig. 6—Cooling rate of outside and center of similar steel samples quenched in water, oil, salt bath and air.

MS point (MS = Martensite Start, beginning of martensite formation). The MS point is not affected by the rate of cooling. As the steel continues to cool, further martensite forms. At any given temperature the degree of martensite formation is the same for the same steel regardless of the cooling rate through this range. By quenching a steel to a temperature just above the MS point, that is, about 400 deg. F., holding it there until temperatures are equalized throughout and then allowing it to cool in air, martensite forms without developing high stresses in the material.

Variations in alloy content in any particular specification may shift the MS point about 15 to 20 deg. F. according to MS point calculations based on Payson's formula. In Fig. 5, MS is plotted against carbon. Above 1 percent C. MS temperature would probably stay constant, because carbon would not be in solution at the normal hardening temperature. Increasing alloy content causes a drop in the MS point, that is, narrows the temperature range between MS and quenching bath temperature. As carbon and alloy contents increase, martensite has less time to form.

Carburized cases usually are 0.90 percent C, sometimes much higher. At 1.00 percent C, SAE 3312 for instance forms martensite over a very narrow

range of temperature in the case, but over a very wide range in the core.

The mechanism of martensite formation and the effect of different quenching media is illustrated in Fig. 6, assuming that critical cooling rates have been exceeded in all cases and that martensite will form throughout. When a bar is quenched in water, martensite forms first on the outside, the center being so much hotter that no martensite can form. Transformation advances to a considerable extent in the outer layers before it begins in the interior. As martensite-formation increases the volume, this differential transformation develops strains. The slower oil quench will allow the center to cool much more before the outside reaches the MS point, and therefore the amount of martensite formed on the outside before the center cools to the MS temperature is less.

Quenching steel into a hot salt bath above the MS point also produces a temperature gradient, but it is eliminated by holding the part in the bath for a time, the length of time required depending on the section of the part. Subsequent air cooling is so slow that it will not reestablish the temperature difference, the part cooling and transforming as a whole. Dimensional distortions and tendencies to crack, as in oil or water quenching, are reduced to a minimum. Air-cooling after the hot salt bath quench is essential, as a more rapid quench will again create internal stresses.

When martempering was first used, the salt-bath temperature was adjusted to be always slightly above the MS point of the steel, but now a uniform temperature of 400 ± 25 deg. F. is employed.

Martempering is compared in Fig. 7 with oil-quenching in respect to hardness level and depth for bar sizes from ¼ through 1¼-in. round. Hardness traverses found the action of the two media almost identical, although oil is the distinctly more active agent.

While the action of the salt bath approaches that of oil, distortion and cracking are minimized. A heavy spline with a partially notched keyway, a sharp bottom and sharp fillet, threads and holes through the bottom countersunk was submitted to the author, each end looked as though it had been stamped with a sledge-hammer. That type of part, especially in the intensively hardening NE 8447, usually breaks in normal oil hardening, and an interrupted oil quench has to be applied. When it was martempered, this part not only did not break, but gave a surface hardness superior to that obtained by the interrupted oil-quench.

Table II, taken from an article by J. M. Thompson, Jr., in "The Iron Age" of March 8, 1945, points up the mechanical advantages of martempering by comparing impact resistance and hardness of three steels after being either oil quenched at 70 to 150 deg. F. or after hardening in a salt bath at 500 deg. F.

Thus the foregoing discussion shows that the new process usually requires a slightly more hardenable steel to achieve a given hardness, thereby it tends to increase raw material cost somewhat. However, if uniformity and rejections are a primary consideration, martempering will lead in greater economy. Mass effects which have an important bearing on the relative merits of water, oil and salt bath quenching will be further discussed in a continuation and conclusion of this article.

Table II — Effect of Martempering on the Impact Resistance And Hardness of Three Steels

Steel		SAE X 4130				SAE 4140				SAE X 4340			
Mechanical Properties		Impact Resistance ft. lb.		Hardness Rockwell "C"		Impact Resistance ft. lb.		Hardness Rockwell "C"		Impact Resistance ft. lb.		Hardness Rockwell "C"	
Quenched In		Oil	Salt	Oil	Salt	Oil	Salt	Oil	Salt	Oil	Salt	Oil	Salt
As Hardened		22	42	45.5	29.5	6	20	52.0	48.0	14	23	54.0	49.0
Draw Temp. Deg. F	600	14	32	44.2	32.6	7	13.5	47.5	46.5	14.5	19	47.7	47.6
	750	21.5	32	42.1	31.1	11	16	45.7	43.6	18	19.5	45.2	45.9
	900	52	50.5	33.2	25.3	41.5	43	37.0	35.9	40	41	38.1	36.5
	1050	87	91.5	25.1	18.4	66	75	31.6	27.5	63.5	74	32.2	29.5
	1200	98	107	20.2	13.0	81	91.5	25.5	20.3	83	90	25.6	22.2

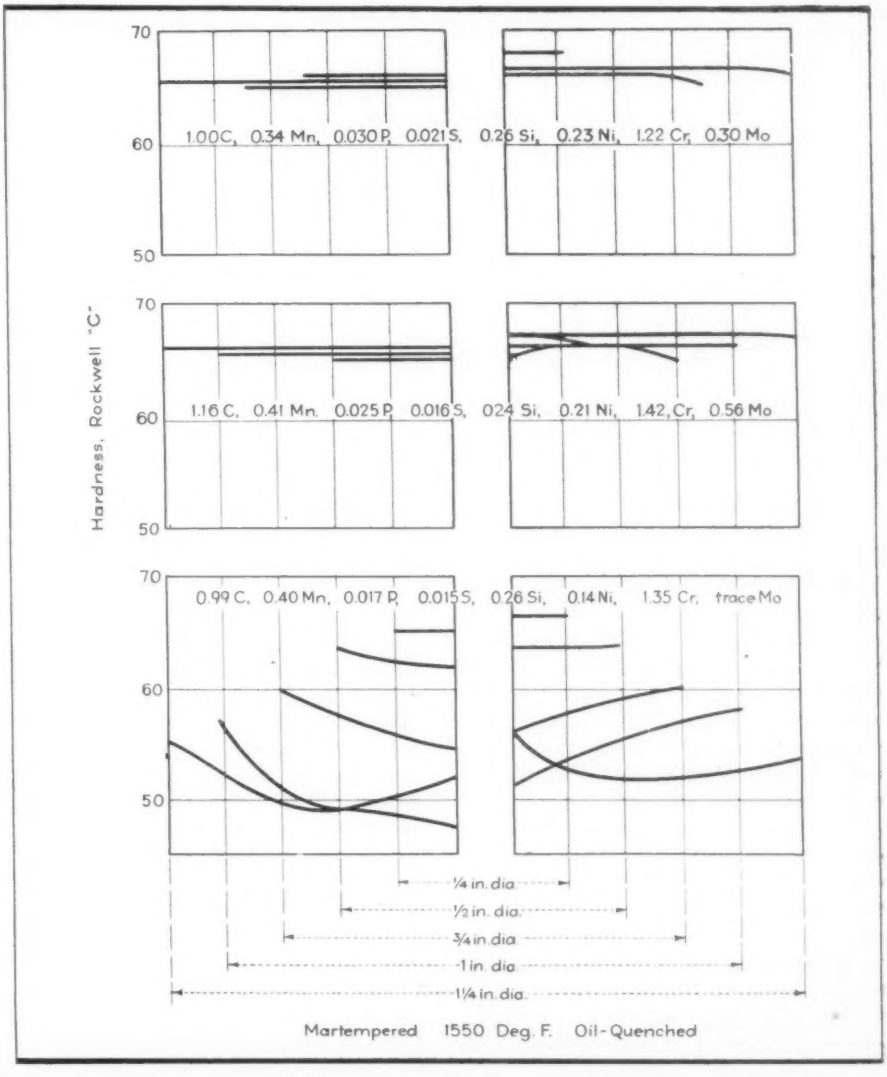

70
60
50
1.00C, 0.34 Mn, 0.030 P, 0.021 S, 0.26 Si, 0.23 Ni, 1.22 Cr, 0.30 Mo
1.16 C, 0.41 Mn, 0.025 P, 0.016 S, 024 Si, 0.21 Ni, 1.42, Cr, 0.56 Mo
0.99 C, 0.40 Mn, 0.017 P, 0.015 S, 0.26 Si, 0.14 Ni, 1.35 Cr, trace Mo
Hardness, Rockwell "C"
¼ in. dia.
½ in. dia.
¾ in. dia.
1 in. dia.
1¼ in. dia.
Martempered 1550 Deg. F. Oil-Quenched

Fig. 7—Martempering against oil quenching, mass effects on low-alloy tool steels.

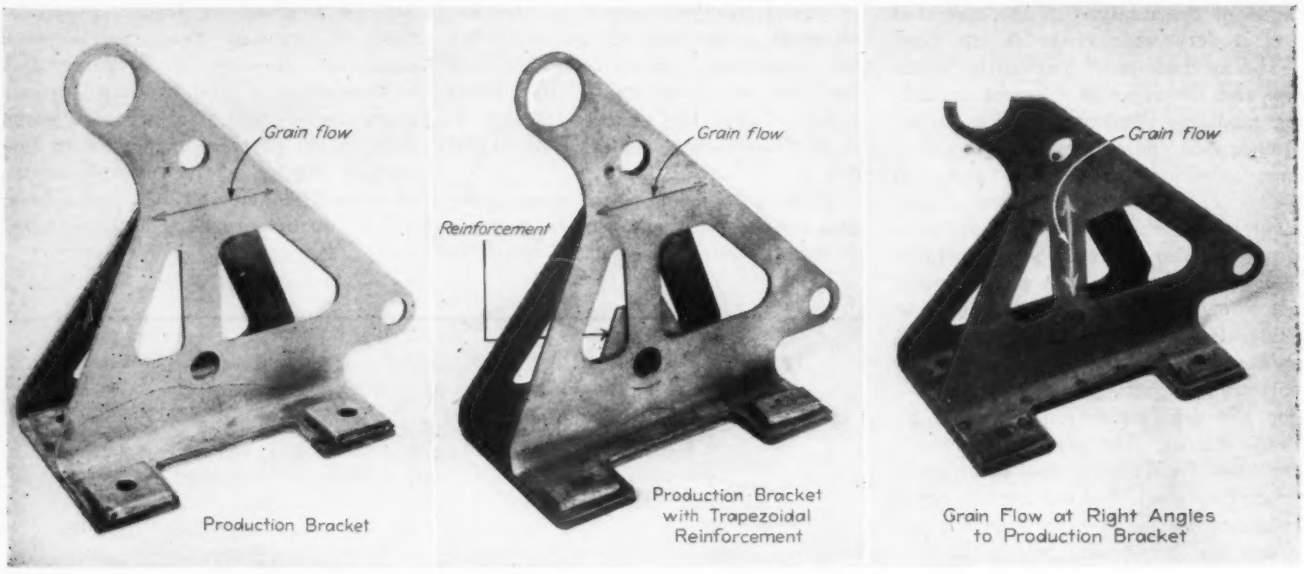


Fig. 1—Oil filter brackets which have been etched after failure of fatigue tests.

Fatigue Life of Parts As Affected by Grain Direction

D. D. STONE

Director of Research, Willys-Overland Motors, Inc.

Improvement of fatigue life, in a sheet metal bracket assembly, was doubled through a change in grain flow direction. The author describes the tests that were made which resulted in redesign for increased fatigue life.

FIELD reports indicated that fatigue failures were occurring in the oil filter bracket of the Willys Jeep. Failure of the oil filter brackets was by longitudinal cracking near the center stud hole in the direction of the metal grain flow. This led to a test program to study the problem and develop a new bracket that would have a satisfactory fatigue life.

In the test program, oil filter brackets were mounted on an engine in the regular manner. The engine was then run on a dynamometer from an idle to the speed which would give the maximum amplitude of the bracket vibration. This engine speed was then maintained and the vibration amplitude checked at 15 min. intervals. When the engine speed for maximum bracket amplitude changed the bracket was inspected for cracks. After failure each bracket was etched in an acid solution.

Tests were made on three designs of brackets; the production bracket, the production bracket with a trapezoidal reinforcing washer and a bracket with metal grain flow at right angles to that used in the production bracket. These three brackets and their resulting failures are shown in Fig. 1. The production bracket failed in 30 hr. The production bracket with trapezoidal reinforcement failed in 37 hr. The bracket with metal grain flow at right angles to the production bracket failed in 56 1/2 hr. Another similar bracket ran 76 1/2 hr.

The addition of the trapezoidal reinforcing washer gave too small a comparative improvement. Changing the direction of metal grain flow doubled fatigue life and thus would give a sufficient increase to justify the change in design.

It is interesting to note in Fig. 1 that the fatigue failures in all brackets occurred by cracking longitudinally on the lower bracket near the center stud hole. The change in metal grain flow resulted in cracks that were not as extensive as when grain flow was in the direction of the cracks.

This development points out the importance of metal grain flow direction when designing parts which will be subjected to fatigue loads. It indicates that to obtain maximum fatigue life a designer must consider the grain flow direction in all sheet metal parts. Grain flow should be at right angles to the flexure of the part.

Resistance Wire Strain Gage Applications and Circuits

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Douglas Research Laboratories, Douglas Aircraft Company

Application techniques and problems of making and mounting resistance wire strain gages for stress-strain analysis are discussed in detail. The authors describe strain gage circuits sensitive to stretch, bending, shear, torque, pressure and displacement.

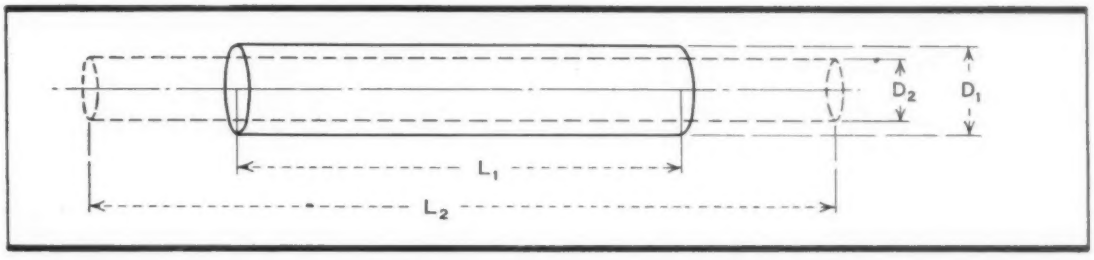


Fig. 1—Enlarged section of a strain gage wire. The dotted outline indicates effect of strain.

THERE are many ways of measuring small mechanical displacements or strains. No one method is best for all applications. There are two broad types of gages or pickups; the mechanical strain gage and the electric strain gage. The mechanical strain gage is often highly advantageous because no auxiliary equipment is required. Generally, however, it requires levers or gears to amplify the motion. The mechanical extensometers are one such example. A dial gage can often be used with excellent results.

When it is necessary to measure or record strain at a point a considerable distance from the test structure or to measure rapidly changing loads, electric strain gages are required. They are applicable under such circumstances because they generally have low mechanical inertia and the signal from them can be transmitted over wires. There are many types of electric strain gages such as resistance wire, electro-magnetic, crystal, carbon strip and others. Each has its specific field of application.

The resistance wire strain gage is probably the most versatile single type gage available. It can be installed in almost any location and no structural modification or holes are required. Further, they are light and mechanical vibrations or strains of almost any frequency can be measured. Properly installed, strain gages are stable and will give reliable results for years. The cost is so low that recovery of the gage is unnecessary. When a number of gages are necessary to analyze a large structure statically or dynamically, or both, the resistance wire gage is the only practical method. In the balance of the article, the term "strain gage" or simply "gage" will apply only to the resistance wire strain gage.

A partial explanation of the physics underlying the strain gage can be given in fairly simple terms. Consider a piece of fine wire of length L_1, as shown in Fig. 1, and suppose that, as a result of tension, the wire is stretched to a length L_2. The original diameter D_1 of the wire is thereby reduced to a value D_2. If the wire were compressed, its length would decrease and its diameter would increase. Actually, the changes in dimension are generally kept below one percent.

It is a basic electrical fact that the resistance of a wire is proportional to its length and inversely proportional to its cross-sectional area. If, then, the length is increased and the cross-section reduced, the electrical resistance will increase. In addition, the stress upon the wire has a direct effect upon the resistance which is independent of the dimensional change; the latter variation in resistance depends upon the specific material.

It is convenient to relate the fractional change in resistance with the fractional change in length of the gage by the ratio

$$(\delta R/R)/(\delta L/L).$$

This ratio, which is called the gage factor, is tabulated for many types of wire and types of gages. Suppose, for example, that the gage factor is 2, a value which applies to some of the more commonly used gages. If a 1 in. long gage is stretched 0.001 in. or 0.1 percent, the electrical resistance of the gage would increase by 0.2 percent; conversely, if the electrical resistance were to change by 0.2 percent it would be known that the length must have changed by 0.1 percent.

A resistance wire strain gage consists of fine wire wound back and forth in the form of a grid, to obtain a conveniently high resistance, and attached to a thin piece of paper. It is electrically insulated from the specimen by the paper, and the whole gage is cemented, as shown in Fig. 2, to the metal which is being tested. If the piece of metal is stretched by a force F parallel to the long axis of the gage, the fine wires of the gage also stretch, since they are securely bonded to the metal. The paper acts only as a temporary vehicle, since the strain is transmitted to the wire by the bonding cement. The

Some of the equipment and apparatus described in this article are covered by U.S. Patent No. 2374512 and other patents pending.

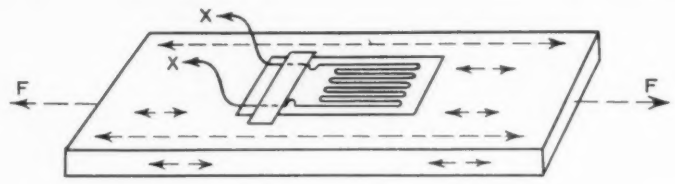


FIG. 2

Fig. 2—Section of material subjected to tension showing a strain gage bonded to the surface.

Fig. 3 — Temperature-resistance curves for three types of gages bonded to aluminum.

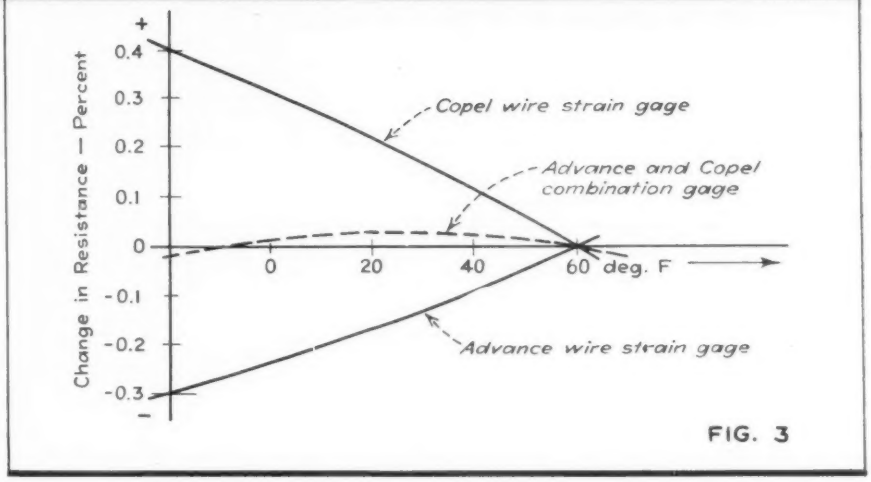


FIG. 3

electrical resistance of the gage, measured at the terminals *X-X*, increases as the metal is stretched and decreases as the metal is compressed. If, however, the force is applied at right angles to that indicated, the resistance changes only by the amount dictated by Poisson's ratio.

In a simple structure where the direction of application of force or stress is known, it is relatively easy to compute the stress in terms of resistance change of the gage and the elastic modulus of the sample. In a complex structure where only the material properties are known, but not the direction of application of stress, several gages can be arranged at different angles. The relative change in resistance of the several gages can then be used to calculate both the direction of the applied stress and its magnitude. The strain gage thus forms a powerful instrumentation tool for the precise measurement of magnitude and direction of stress under nearly any circumstance.

The small magnitude of resistance change produced by strains renders accurate measurement of the strain difficult, since extraneous fluctuations resulting from temperature changes are of comparable magnitude. These errors can be satisfactorily reduced.

If a piece of metal shown in Fig. 2 is heated or cooled the resulting expansion or contraction does not produce any stress unless the metal is constrained. The resistance value measured at the terminals *X-X* will, in general, change since the resistance of the strain gage wire changes with temperature, and the wire may expand or contract by an amount which is different than that of the base metal. If the amount is different, a net tension or compression is in effect applied to the gage. The effect of the extraneous fluctuations can be minimized by using a "dummy gage" which is subjected to the same temperature change, but to no stress. The difference in resistance change between the active and dummy gage is then a measure of the stress.

Certain resistance wire base metal combinations show little change in resistance with temperature as a result of the coincidental relationship between the separate thermal coefficients. Each resistance wire alloy has a different net thermal coefficient when used with a specific base metal. Some are negative, other are positive. By judicious choice of the relative quantity of negative and positive coefficient wires in a specific application the gage temperature coefficient can be made to approach zero.

Temperature-Compensated Gages

Advance, a constantan-type alloy, is the most popular material for strain gage wire. Another commonly used material is Copel. If an Advance wire gage is pasted to a piece of aluminum the change in the resistance observed as a function of temperature with no stress applied is that shown in Fig. 3. A similar curve for Copel also appears in Fig. 3. The Copel gage has a useful property, namely, its resistance decreases with a rise in temperature. A single gage which employs both Advance and Copel wire can display only a small change in resistance with temperature, as represented by the dotted curve in Fig. 3. It is impractical to further improve the temperature compensation, since the individual temperature coefficients are not linear. Fortuitously, the combination of an Advance gage on steel has a low temperature coefficient of resistance and frequently no additional compensation is required.

A list of strain gages for most applications is available commercially. The Douglas Company has, however, fabricated gages for its own use for about 5 years. The manufacture is done in 3 steps; (1) winding or stringing, and cementing the grid to the paper base, (2) final adjustment of the resistance of the gage by proper positioning of the lead wires, and (3) cementing of reinforcing strips across the lead-grid junction.

The first operation is performed with the aid of an ingenious jig, Fig. 4, developed by W. D. Van Dyke of the Douglas El Segundo Engineering Department. The strain sensitive wire of 1 or 1½ mil dia. is shown in place prior to the stringing operation. The needles, which are modified Torrington knitting needles, are drawn back one at a time. When all of the needles have been pulled back the grid is formed. The pedestal carrying the 0.0007 in. thick cigarette paper is then raised so that the wire grid can be cemented to the paper base. The gage is removed from the jig after about 30 sec. of drying by releasing the needles. The number of loops and stroke of the needles determine the approximate resistance of the gage. An inch long gage made of four loops of one mil Advance wire will have about 200 ohms resistance.

The final adjustment of the gage resistance is made at the time the copper lead wires are attached, Fig. 5. For example, if the resistance of the gage is high, it is adjusted by relocating the soldered junction between the lead

and the strain wire closer to the grid. The final resistance of the gages is held to a tolerance of plus or minus 0.15 percent.

The gage is reinforced by cementing an extra layer of cigarette paper across the junction between the leads and the grid. The large lead wires cannot be successfully bonded to the base metal. The hook at the gage end of the lead is intended to prevent slipping at that point and to eliminate much of the strain transfer from it to the grid wire. The hook also gives better mechanical strength when the gage, after being cemented in place, is wired to the resistance measuring device.

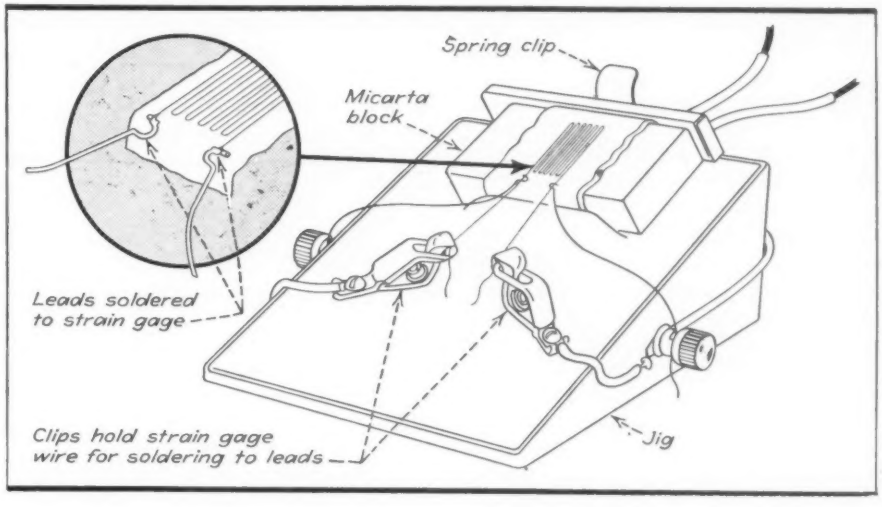
Mounting the Strain Gages

The selected gage position must first be cleaned with a volatile solvent that will remove all traces of oil, paint or grease. Often it is advisable to remove the heavy cadmium plating used on some steel parts. A light coating of cement is then applied to both the gage and the structure. With the gage in position the excess cement and bubbles are pressed out with the end of the finger, using a rolling-pin motion, Fig. 6, to work the excess cement toward the lead end of the gage. Gages must be well cemented for two reasons; (1) to insure that every portion of the strain gage grid is thoroughly bonded to the specimen, and (2) to carry away the heat produced by the electrical current flowing through the gage.

A newly mounted gage must be checked often for the formation of bubbles beneath the paper base, since, if the volatile thinner in the cement evaporates into any air space the tiny bubbles will grow. While working out the excess cement and bubbles, extreme care must be taken to prevent the gage from tearing or shifting its alignment. It is impossible for a strain gage to give an indication that is high, but an improperly mounted gage will read low.

The normal drying time for the first coating of cement is about 1/2 hr., at which time an additional coat is applied. The final coat should be allowed to dry for 24 hr. If the gage has dried for 4 hr. under ambient conditions, the drying operation can be completed by

Fig. 5—Strain gage calibrating jig used for attaching leads to allow precise adjustment of gage resistance.



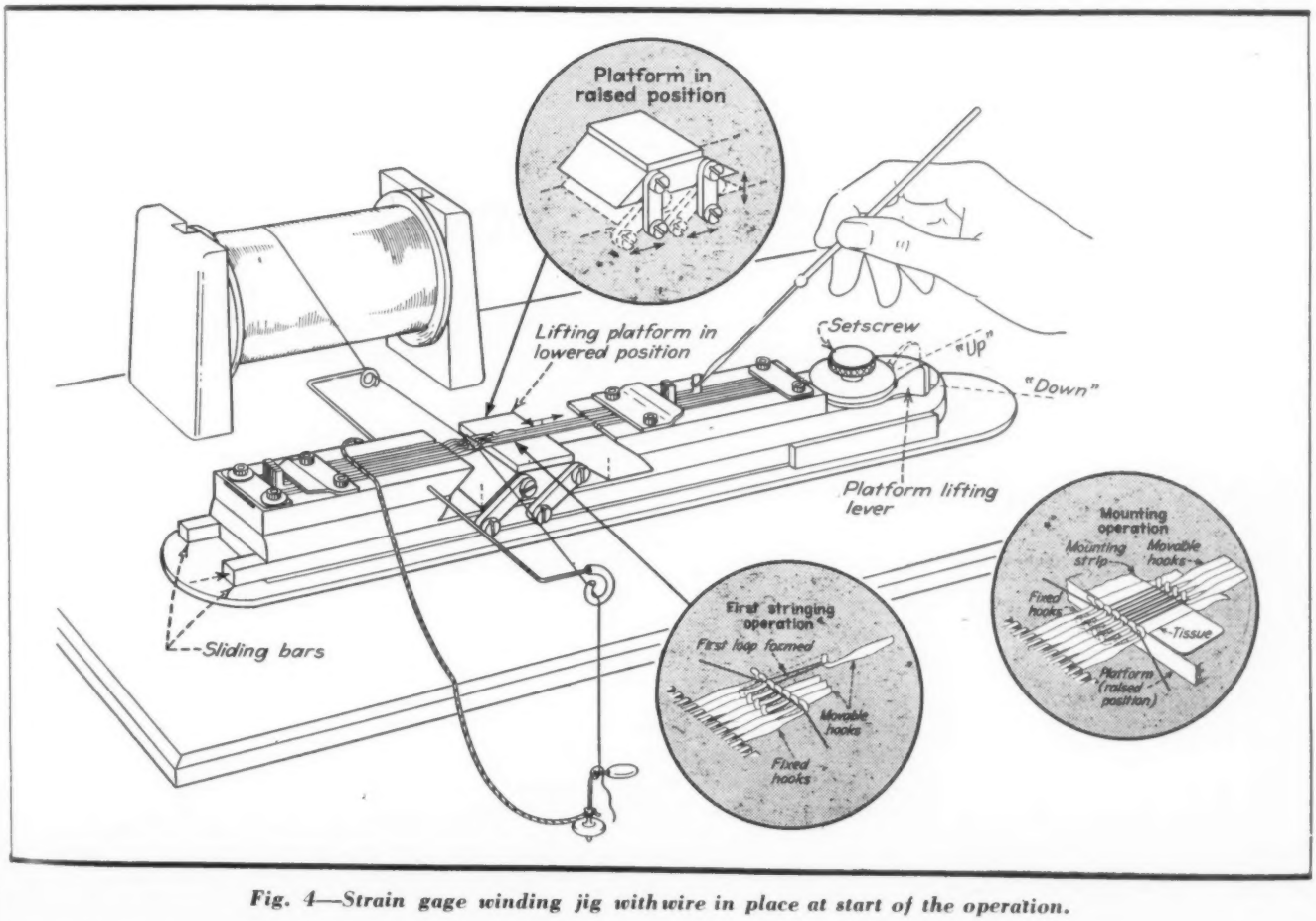


Fig. 4—Strain gage winding jig with wire in place at start of the operation.

baking at 150 to 200 deg. F. for 2 hr. The initial drying period reduces the possibility of formation of bubbles during the baking process.

To date the Douglas Company has found General Electric No. 1276 Glyptal and General Cement Company Service Cement to be the most satisfactory for mounting gages under average conditions. It has been found helpful to apply an extra coating of cement or non-hygroscopic wax, when humidity is excessive. Special bonding techniques are available for high temperature applications and gages have been used successfully at temperatures as high as 1,000 deg. F.

Circuits

Two different methods are used to measure the change in resistance produced in the strain gage. These are called the "ballast" system, Fig. 7, and the "bridge" system, Fig. 8. The ballast system is less complicated than the bridge system, but is unsatisfactory if slow fluctuations in strain are to be measured. It is adequate for most vibration problems where only relatively rapid fluctuations are of interest. A bridge system is used when it is important to know the total instantaneous strain, which includes the effects of any sustained loads plus the superimposed fluctuations resulting from motion or vibration. To simplify the explanation, we will consider the case where the meter is a high resistance device which requires a negligible current to produce an indication. Often a vacuum tube voltmeter is used. The measuring system best suited to a specific test will be discussed in a subsequent article.

If in Fig. 8 the resistance of the four arms of the bridge represented by R_1, R_2, R_3 and R_4 are all equal, then the battery voltage E, from A to D, is divided equally across R_1 and R_2, and also across R_3 and R_4. In other words, the voltage from A to B will equal the voltage from B to D, and similarly, the voltage from A to C will equal the voltage from C to D. Therefore, a voltmeter connected between B and C will not deflect. Suppose, however, that the resistance R_1 is a strain gage with a resistance equal to R_2 when no stress is applied to the member being tested. If the specimen is stretched, the resistance of the strain gage will increase, so that the voltage from A to B will increase. The voltmeter connected from B to C will deflect. If the specimen to which the gage is attached is under compression, the resistance R_1 will decrease. The voltage drop from A to B will decrease and the voltmeter will deflect in the opposite direction.

An important property of a bridge is that, for the small changes encountered in strain gage work, the deflection is proportional to the difference between the resistance of two adjacent arms. Suppose R_1 and R_2 are both initially equal so that the voltage from B to C measured by the indicating meter is zero. If both resistors change to a new value but remain equal, the bridge will still be balanced and no deflection will occur. Another important fact is that if the two arms of the bridge R_1 and R_2 change an equal amount in opposite directions, the deflection of the voltmeter will be twice the amount obtained with only one arm in which resistance can be changed.

Often an a.c. source is used instead of the battery shown in the diagram, since a vacuum tube voltmeter, used to measure the output voltage from B to C, can be made more stable for a.c. voltages. An additional modification used at Douglas is that the resistors R_3 and R_4 of Fig. 8 are replaced by a transformer with center-tapped secondary winding, Fig. 9. The same result is achieved, since the supply voltage from A to D, which is now an a.c. voltage, is still divided equally at terminal C.

Suppose a structural member is sup-

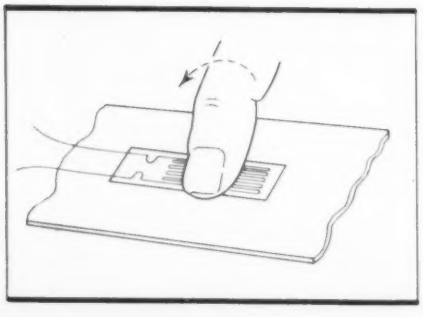


Fig. 6—Method of working out excess cement when mounting a strain gage.

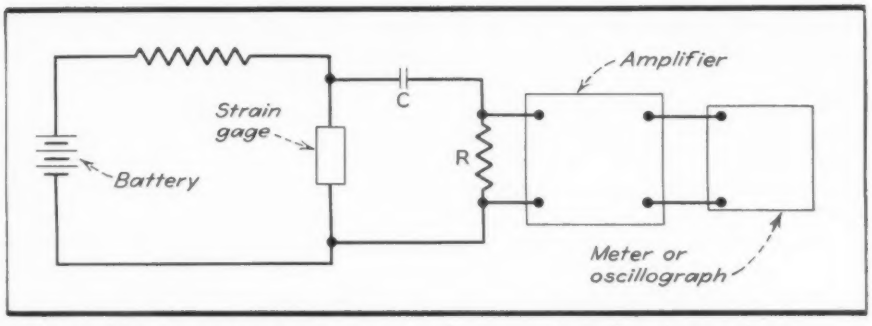


Fig. 7—Ballast or potentiometer system for measuring changing strains.

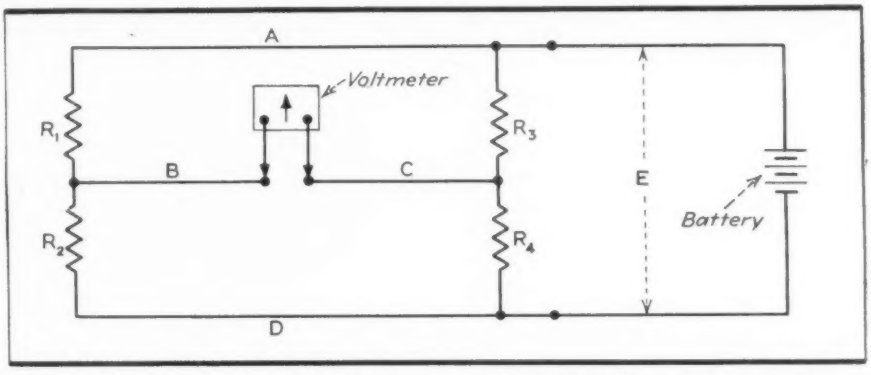


Fig. 8—Equal resistance arm Wheatstone bridge which forms the basis for all strain gage circuits where steady and dynamic changes are to be measured.

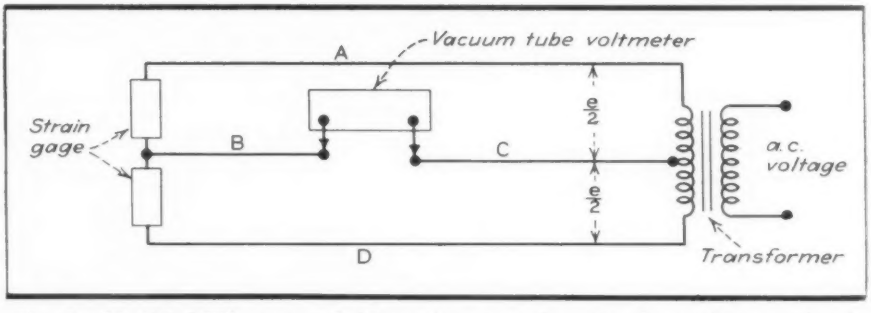


Fig. 9—Modified Wheatstone bridge using a.c. voltage in the strain gage circuit.

porting a load in such a manner that bending and compression are both present, Fig. 10 (*A*). The strains corresponding to the two components can be separated by taking advantage of the characteristics of the Wheatstone bridge. If only the compression component is desired, the strain indicated by either of the gages *X* or *Y* would be in error. The strain indicated by the gage at *Y* would be high as a result of the bending, and similarly, the indication of the gage at *X* would be low by an equal amount. The sum, however, of the strains indicated by the two gages would be correct. If the normal or unstrained resistance of each gage is $1/2R_1$, and they are connected in series, the total resistance would be equal to their sum.

If the series combination of gages *X* and *Y* is placed in one arm of the bridge, Fig. 10(*B*), the deflection of the voltmeter will be proportional to the sum of the changes in *X* and *Y*. This is equivalent to saying that the deflection is proportional to the average of the strains at *X* and *Y*. In such an arrangement the deflection is proportional only to strains resulting from compression or tension loading. If there is no compression or tension, and only bending in the specimen, no deflection of the voltmeter will occur.

Dummy Gages

When strain gages are connected in an averaging circuit only one arm of the bridge is active and all the changes in resistance, resulting from strains, occur in one arm. The opposite arm in the bridge corresponding to R_2 Fig. 10(*B*), could be a precision wire-wound resistor. When this arrangement is used changes in temperature can produce an indication of a fictitious strain without any corresponding loading.

Suppose another strain gage, cemented to the same material as the active gage, is used as the opposite arm of the bridge. Changes in temperature would affect both arms equally. Such a compensating strain gage is called a "dummy" gage. In practice, temperature differences can occur and the compensation is not complete, even though the unstressed material on which the dummy gage is mounted is in the immediate vicinity of the active gage.

In large structural tests, say for example on a section of an airplane fuselage, where as many as 300 separate strain gage locations or "channels" may be used, it has been convenient to use what are called "dummy plates." These are small sheets of aluminum, the same alloy as the structure being tested, each with six dummy gages attached. The dummy plates are arranged in stacks and mounted at a central location on the structure so as to assume approximately the same temperature.

Bending Gages

Often it is desired to measure only the strain resulting from bending in the presence of simultaneous strains from compression or tension loading. The method of mounting the gages is shown for a lever in bending, Fig. 11(*A*). Gages marked *T* will indicate tension strain, and gages marked *C* will indicate a compression strain for the force shown in the sketch. Since these gages are connected in opposite arms of the bridge, Fig. 11(*B*), equal changes, such as those produced by tension or compression loads along the axis of the lever or by temperature fluctuations, will produce no indication on the voltmeter. Only the strain resulting from bending is measured. Further, since the gage *T* increases in resistance and the gage *C* decreases in resistance by an equal amount, the sensitivity is doubled. The advantages of superior temperature compensation and high sensitivity results in the use of the bending arrangement whenever it is possible.

Rosette Gages

Frequently when the loading or structure is complicated, the direction of the strain is not known. Measurements from three separate gages oriented in different directions are then necessary to determine the direction and magnitude of the principle strain. Such an arrangement of gages is called a "rosette." Two types of rosettes are in common use. The triangular or delta rosette, Fig. 12, has been most popular.

The 3 gages of the rosette are mounted on a single piece of base paper and are accurately oriented to form an equilateral triangle. A separate measurement is made for each gage. The magnitude and direction of the principal strain can be computed using a set of trigonometric relations which involve Poisson's ratio, Young's modulus and the gage factor. The calculation is somewhat laborious and normally requires about 10 min. An electrical computer has been developed at Douglas which allows the calculation to be made in about one min. When it is realized that a single test may involve over 1,000 separate measurements, the value of such short cuts can be appreciated.

In a proof test on a structure such

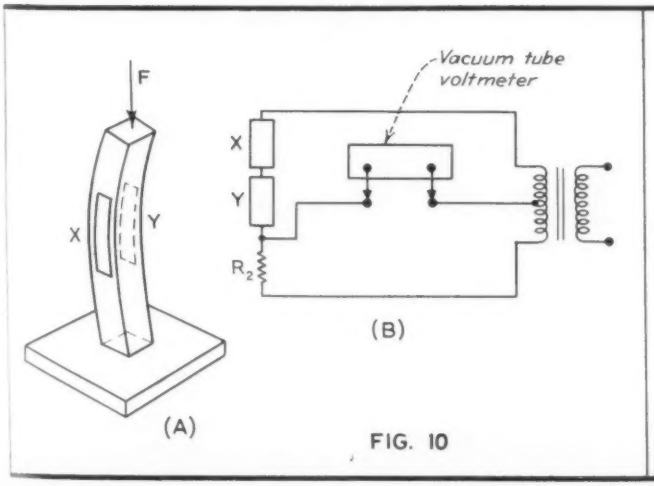


FIG. 10

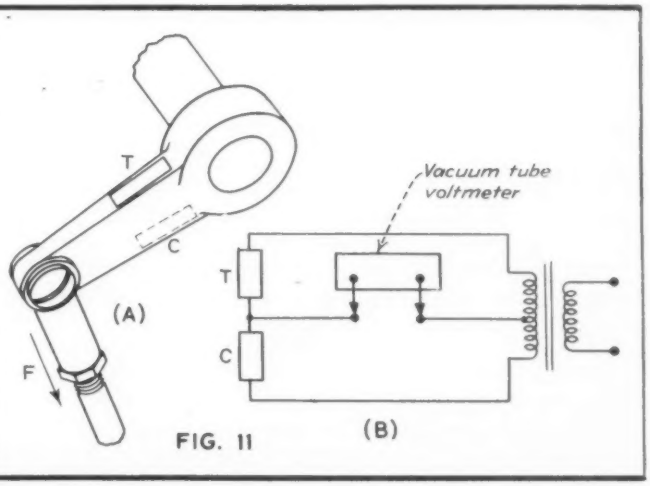
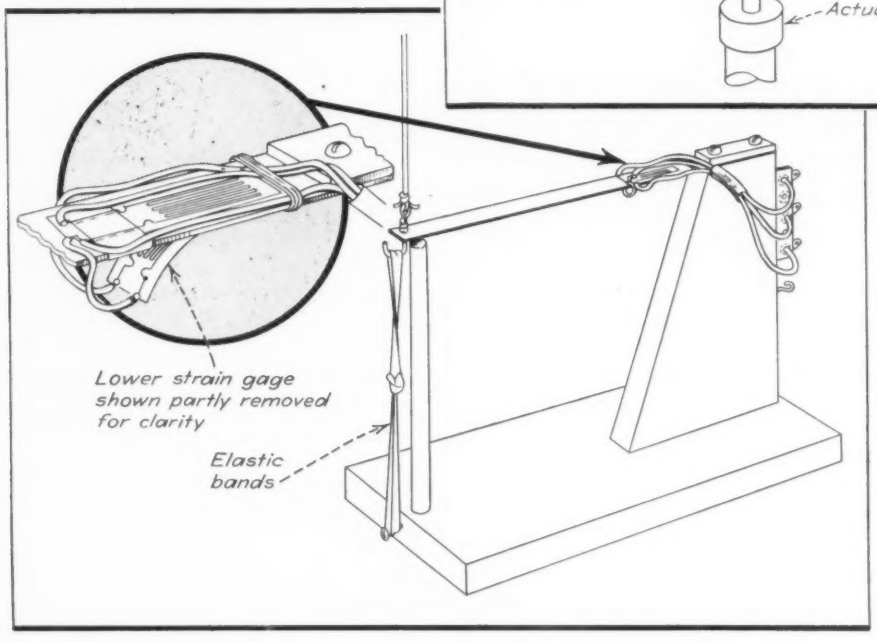


FIG. 11

Fig. 10—(A) Structure with compression and bending strains. (B) Averaging strain gage circuit sensitive only to compression and tension. Fig. 11—(A) Arrangement of gages for measuring strains resulting from bending in a lever. (B) Circuit for the gages.

Fig. 12—Three separate gages must be used if the direction of the strain is unknown. This arrangement is called a delta rosette.

Fig. 13 (Below)—Strain gage bending beam deflection pickup.



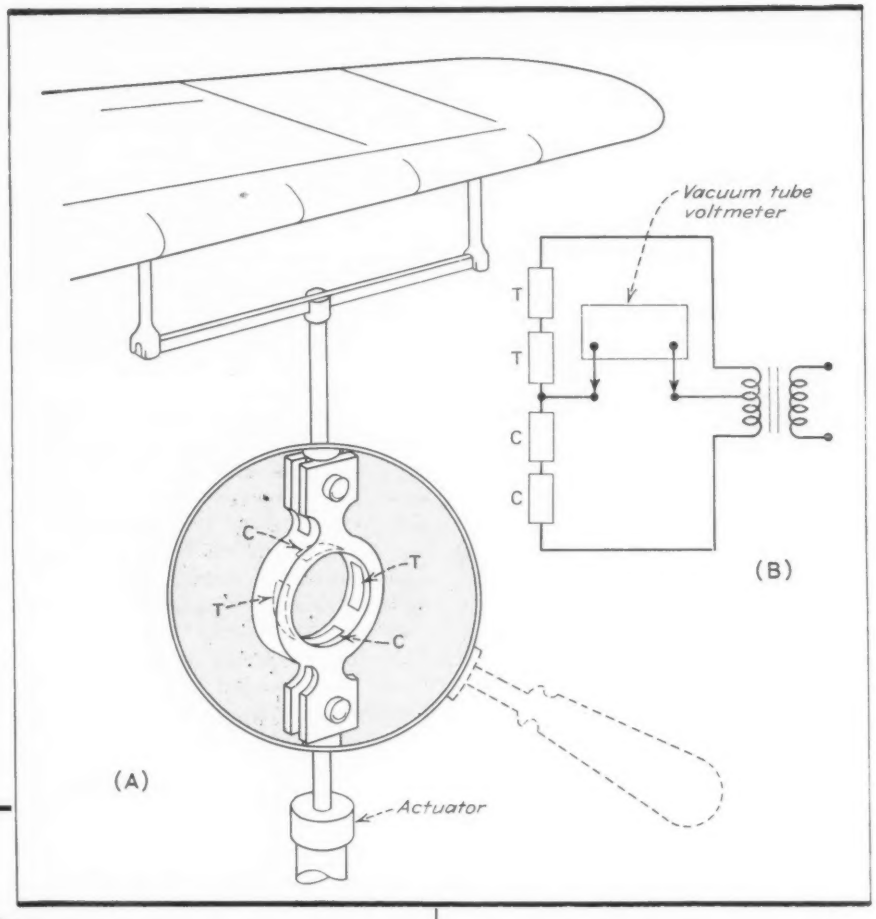


Fig. 14—(A) Strain gage ring type force dynamometer. (B) Circuit for gage connection.

as a wing section, the deflections at various stations resulting from a given load condition must be accurately measured. It is convenient if these measurements can be made electrically and recorded by strain gage measurements. An inexpensive device, Fig. 13, for measuring small mechanical displacements depends upon the measurement of the strain resulting from bending in a thin dural beam.

The beam is mounted so that the deflection to be measured produces cantilever bending. Proportions of the beam should be such that the displacement to be measured does not cause any permanent set in the material of the beam. If a displacement pickup of this type is used in a vibration study it is necessary that the resonant frequency of the beam itself be higher than the frequency of the vibration.

In most structural tests the forces are applied with hydraulic jacks and it is necessary to know accurately the force applied. A convenient device for measuring such forces employs a ring similar to proving rings for calibrating testing machines. Such a ring can be calibrated in terms of pounds of force, and under normal conditions the calibration will be found to be constant within 1 or 2 percent over periods of several months. The rings can be calibrated accurately with a standard tensile testing machine or directly with known weights.

A typical use of such a ring is shown in Fig. 14. Gages marked *T* are in tension and gages marked *C* are in compression for a tension load on the ring. The advantages of this device is that high sensitivity and temperature compensation are obtained since strains are similar to those produced by bending.

The ring principle can also be used as a deflection pickup if light gage material is employed. Strain gage deflection rings of this type have been useful where a fixed reference is not available, since the rings can be suspended in mid-air. An example is the measurement of the change in diameter of a section of an airplane fuselage during a static test.

Pressure Pickups

Many large airplanes use an elaborate high pressure hydraulic system for operation of landing gear, wing flaps

and other devices. A remote indicating pressure gage is necessary to study the dynamic characteristics of the hydraulic system in flight.

A pipe will tend to increase in length and diameter when the internal pressure is increased. The temperature fluctuations encountered in the hydraulic system are extreme, and in flight tests can range from below zero to over 140 deg. F. Therefore, strain gages for both arms of the bridge are mounted on the tube to obtain temperature compensation, Fig. 15(*A*). This results in some sacrifice in sensitivity, since the strains in the circumferential and longitudinal directions are both tension strains and are related by a ratio of about 4 to 1. The electrical connection of these four gages is shown in Fig. 15(*B*). The purpose of the multiple gaging is to reduce the effects of bending. Gages *1* and *2* and gages *3* and *4* are averaging gages.

Torque Gages

One of the important problems in aircraft flight testing is the determination of the force necessary to move the control surfaces during maneuvers. This usually requires that a torque or moment be measured.

Two methods are commonly used to determine torque. The first depends upon measurement of the bending in a lever arm which transmits the torque as described in the section dealing with bending gages. The second method consists in measuring the strain on the surface of a shaft which is subjected to torsion loading. If two perpendicular strain gages are mounted, as shown in Fig. 16, with each axis inclined 45 deg., with respect to the axis of the shaft, and the shaft is twisted, the gages will indicate equal and opposite strains. The gages marked *T* will indicate tension strain and those marked *C* compression strains for the load indicated.

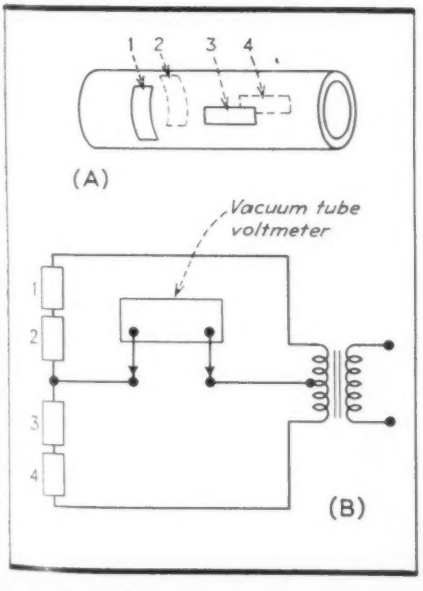


Fig. 15—(A) Strain gage arrangement for measuring the instantaneous pressure in a pipe. (B) Circuit for gage connection.

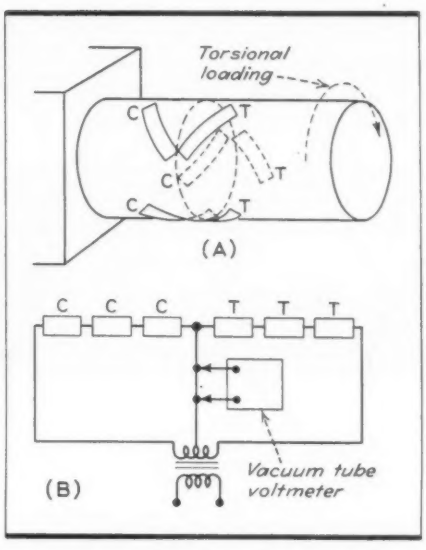


Fig. 16—(A) Orientation of strain gages to measure the torque in a shaft or tube. (B) Three pairs of gages are used to reduce the effect of bending.

In general, because of misalignment or other irregularities, bending forces are also present. If it is desired to have an indication sensitive only to the torque stress in a member it is necessary to use several pairs of gages equally spaced circumferentially and connected as shown in Fig. 16(*B*). All gages aligned in the direction of tension strains are connected in series and form one arm of the bridge, while those mounted in line with the compression strains are connected in series to form the opposite arm of the bridge. An accurate measure of the torque of a rotating machine is made by using torque gages connected through slip rings. In this application it is necessary to mount all four arms of the bridge on the shaft.

An appreciation of the care that must be taken in the process of measuring strains with a resistance wire strain gage can be gained when it is realized that frequently a 0.1 percent change in resistance will result in a full scale deflection of the indicating instrument. For example, a ring used to measure the force exerted by a hydraulic jack may be required to give an indication accurate to 2 percent. If the total change in resistance is 0.1 percent, then the measurement of the gage resistance must be accurate to 0.002 percent.

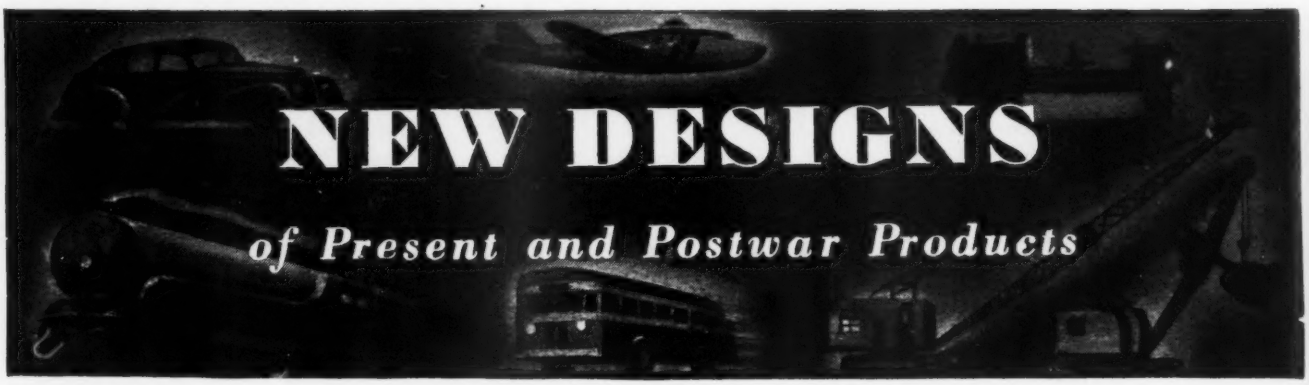
Fortunaterly, it is not necessary to measure the absolute value of the resistance, but only the difference in the changes that occur in the gages mounted on the ring. Fluctuations in the resistance of connecting wires or solder joints cannot be tolerated if accurate results are required. Also, it is necessary to arrange the wiring in a symmetrical manner so that changes in resistance of the copper connecting leads, as a result of changes in temperature, will balance. It is usually necessary to solder all connections which are included within the bridge circuit, but separable plugs can be used to connect the indicator since the total resistance of the indicator is high and a 1 or 2 ohms change is insignificant.

Under ordinary conditions in the laboratory, errors of less than plus or minus 3 percent are obtained on routine tests without individual calibration of the gages. If an answer in terms of deflection, pounds of force in the case of a force ring, or pressure in the case of a pressure pickup, is desired, accurate calibration of the device must be made. Under the latter conditions, it is usually possible to keep the error within plus or minus 1 1/2 percent.

EDITOR'S NOTE: This is the first of two articles on strain gage technique by E. G. Van Leeuwen and W. F. Gunning. The second article will deal with the equipment used for indicating or recording the strain gage data.

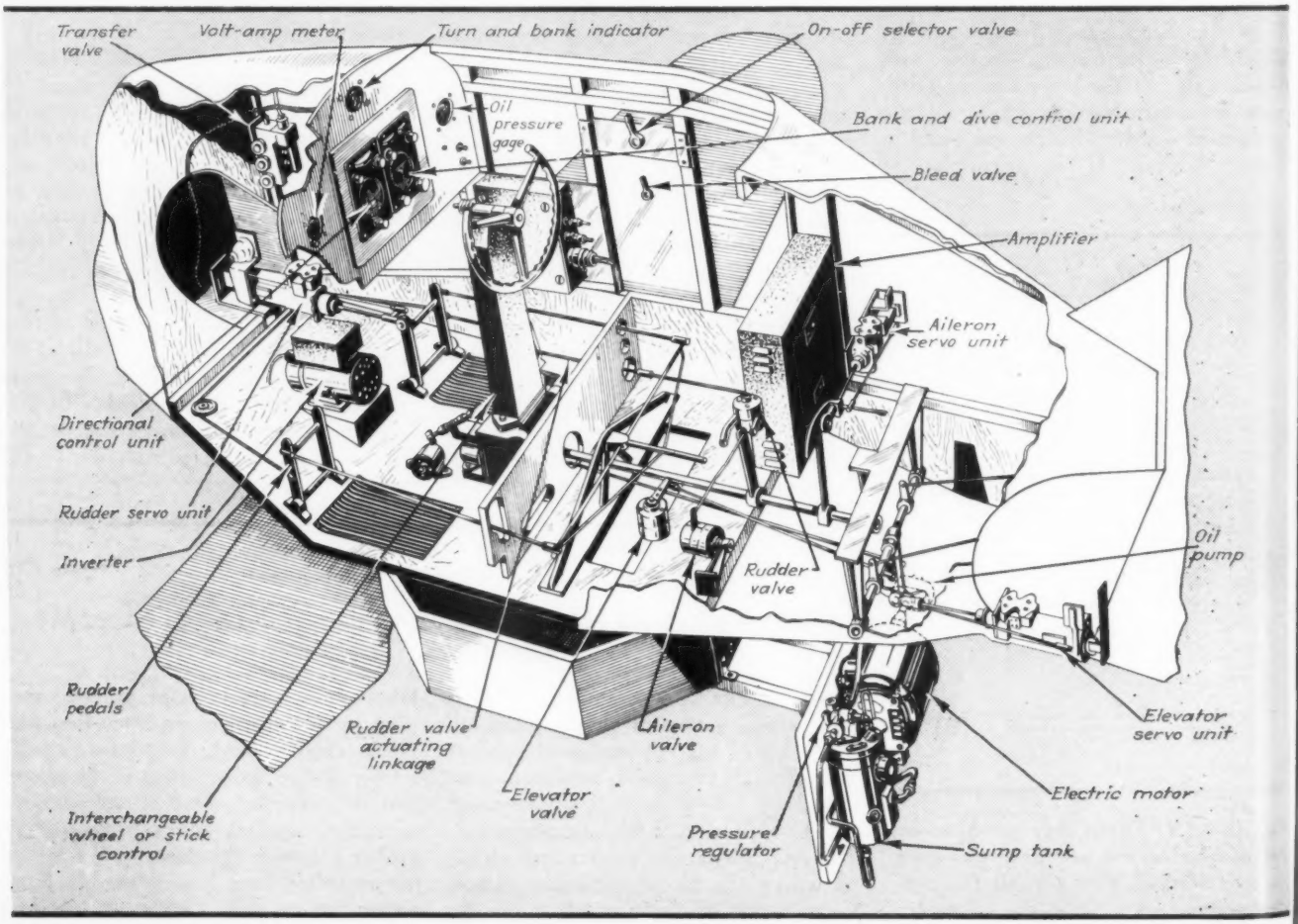
Catapult Seat Designed For Pusher-Type Aircraft

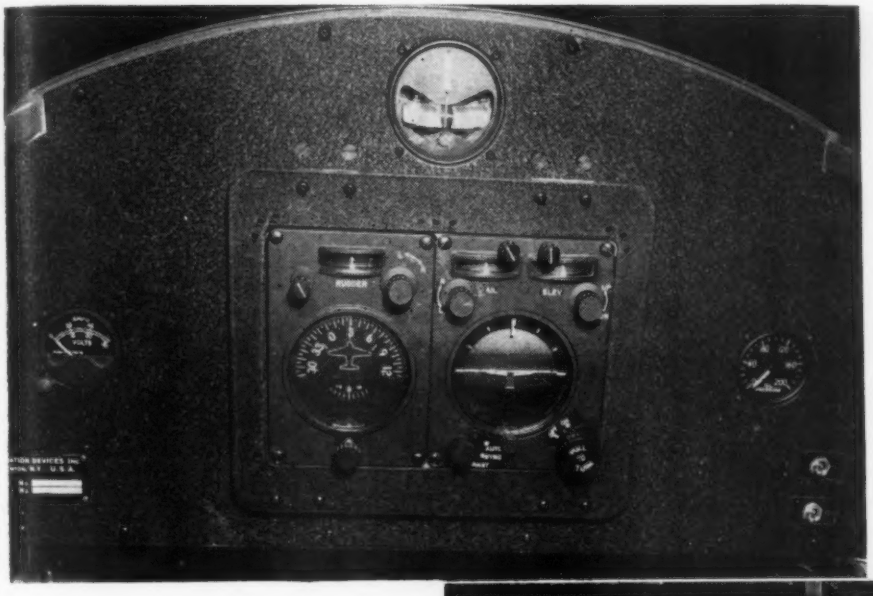
DEVELOPMENT of a catapult seat which will allow aeronautical designers to make use of the efficiencies of pusher-type aircraft propulsion has been completed by Vultee division engineers of the Consolidated Vultee organization. The seat amounts to a miniature elevator powered by an electric motor. When the plane is on the ground, it can be lowered below the fuselage, allowing the pilot to sit down and be lifted into the plane. During flight, the pilot may pull a lever and be thrown clear of the plane and its propellor. One of the factors mitigating against widespread use of pusher planes is the danger of striking the propellor when leaving the plane in an emergency.



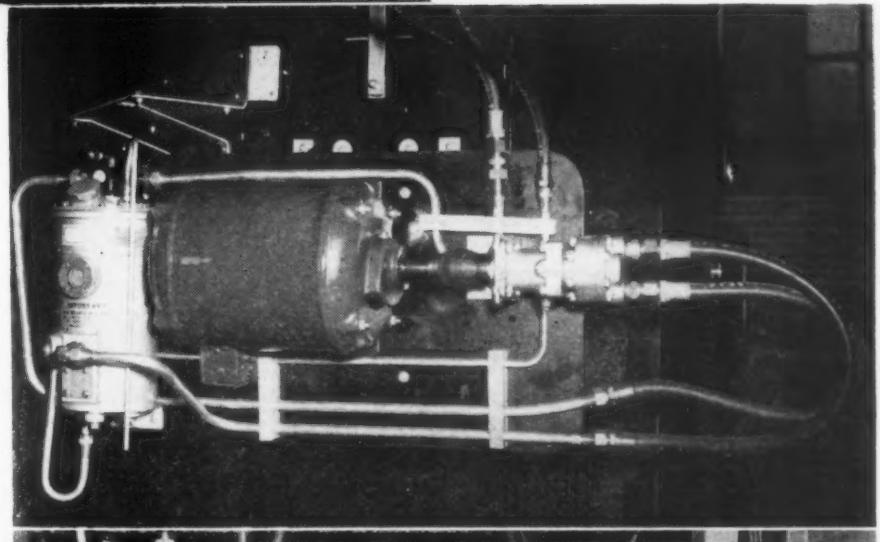
Navy Training Device Has Robot Pilot

LINK TRAINERS equipped with General Electric autopilots and designated Device 7-1-4 by Navy Bureau of Aeronautics Special Device Division are being used in the naval aviation training program to instruct pilots and mechanics in the operation and maintenance of the electro-hydraulic pilot apparatus. The controls and responses are identical with those encountered in standard aircraft, resulting in a more effective and shorter training period. The trainer may be "flown" either manually or with the automatic equipment. Alteration of the basic Link controls and mechanics was found unnecessary in adding the autopilot equipment to the trainer. As described by E. A. Hilbert of the Aeronautics and Marine Engineering Division of the General Electric Company, the installation is made in practically the same manner as it would be in a regular plane without changing the components of the autopilot system or trainer.

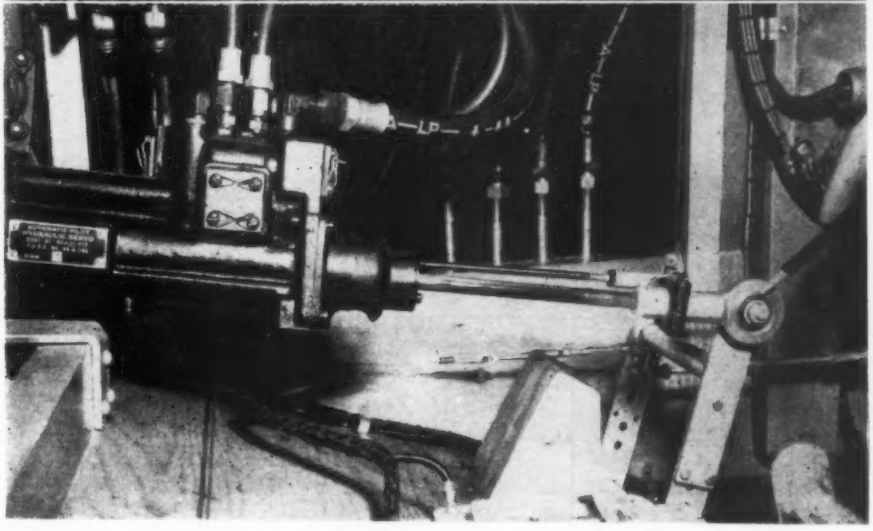




Instrument panel has been simplified by the elimination of tachometers, altimeters, and other instruments which have no bearing on the operation of the autopilot. Turn and bank indicator is used primarily during manual operation, whereas the directional gyro and bank-and-climb gyro controls may be used during manual or automatic operation. The gyro controls constitute the "brains" of the system for maintaining a set course. In addition to the 115-230 volt a.c. normally used for operating the trainer a 27 d.c. supply is used for autopilot operation. This 27 volt supply is brought to the movable portion of the trainer through the slip-ring drum regularly used in the stationary base.

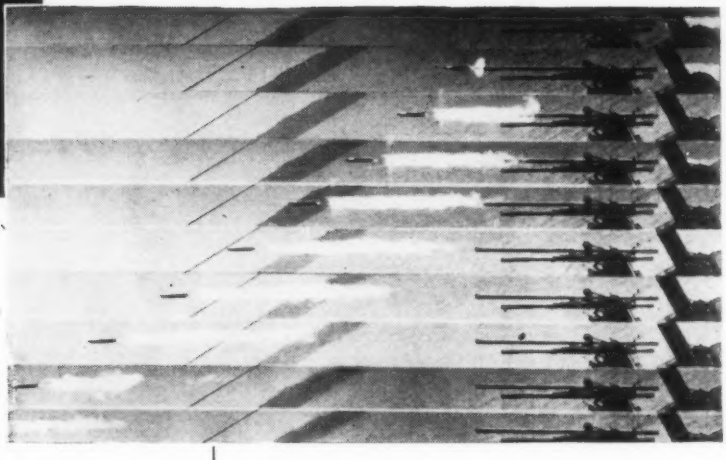


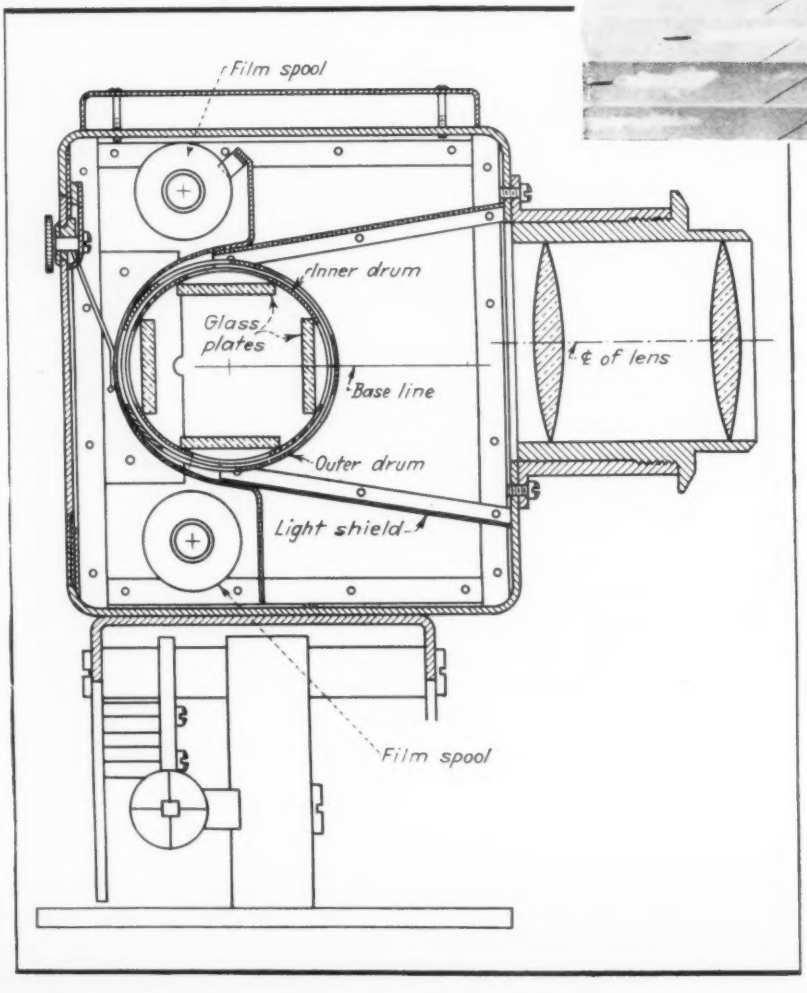
Three separate hydraulic servo mechanisms control the rudder, ailerons, and elevators. Oil at 100 lb. per sq. in. pressure moves hydraulic servo piston rods with a force up to 125 lb. The forces are transmitted to the trainer's regular controls by ball and socket joints located at the end of the piston rods. These are attached through linkages to the control surfaces and the valves of the vacuum motors which cause the trainer to turn, bank, and climb or dive. The illustration shows the simple attachment of the hydraulic servo to the right foot pedal for rudder control. As in a conventional plane, the pilot can overpower the automatic equipment at any time through regular controls. This is accomplished by including adjustable, spring-loaded valves in the hydraulic servo. An inverter for changing the 27 volt d.c. power to 115 volt 400 cycle a.c. 3-phase power is set on the floor of the nose. An electric junction box is located on the side of the cockpit. The weak signals from the gyro instruments are built up by an electronic amplifier located immediately behind the pilot's seat. The signals from the amplifier go to a transfer valve unit in the nose where solenoid-operated valves control the hydraulic system. Proper location of these units involved little difficulty because they are small and light in weight. With practically all hydraulic tubing mounted on the outside of the fuselage, access to the lines is easy.



Since the trainer revolves about a vertical axis, the hydraulic equipment is mounted on the movable portion of the trainer to avoid fouling of hydraulic lines. The oil, pump, pressure regulator, and ¾-hp. 115/220-volt, single-phase motor are mounted on a bracket bolted to the movable part of the trainer and slung beneath the tail. Only two flexible hose lines are necessary to take care of pitch and roll movements. The entire hydraulic equipment revolves about the trainer's vertical axis as the fuselage revolves.

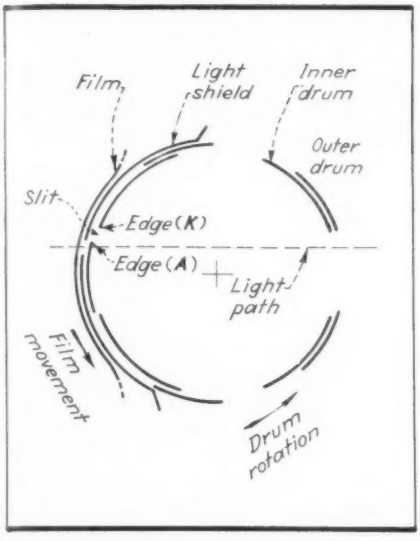
Ribbon-Frame Camera Allows Study Of Rocket Behavior



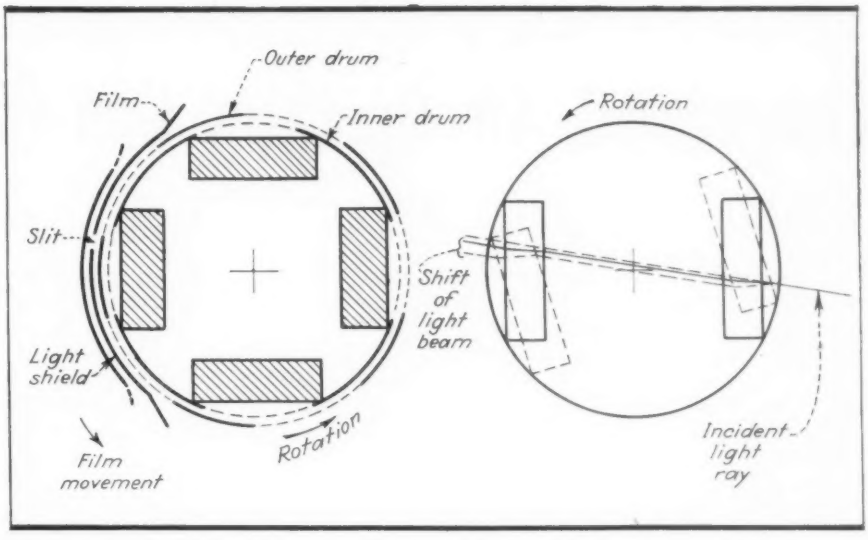


STUDY OF THE BEHAVIOR of rockets during the early part of flight requires some form of high-speed camera. Since the path of a rocket is practically a straight line over moderate distances, a series of ribbon-like pictures is necessary. Thus the camera developed by the Bell Telephone Laboratories Incorporated, from one devised by Dr. I. S. Bowen of the California Institute of Technology is called a ribbon-frame camera. The camera uses a standard No. 122 film which is $\frac{3}{4}$ in. wide and 35 in. long. Film is carried past a 0.15 in. slit and each frame is thus 0.15 in. high and $3\frac{1}{4}$ in. wide. Over 200 frames can be taken on a single film and exposure time is adjustable from 0.0001 to 0.0006 sec.

Shutter arrangement consists of two concentric drums $2\frac{3}{4}$ in. in diameter and $4\frac{1}{2}$ in. long. The drums are rotated in the same direction but at slightly different speeds by a single constant-speed motor. Drum slots run nearly from end to end with four slots in the inner drum and five slots in the outer.

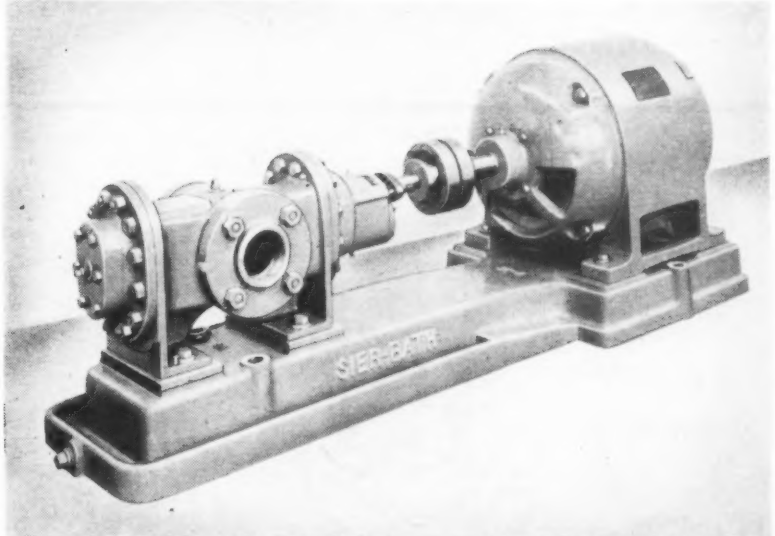


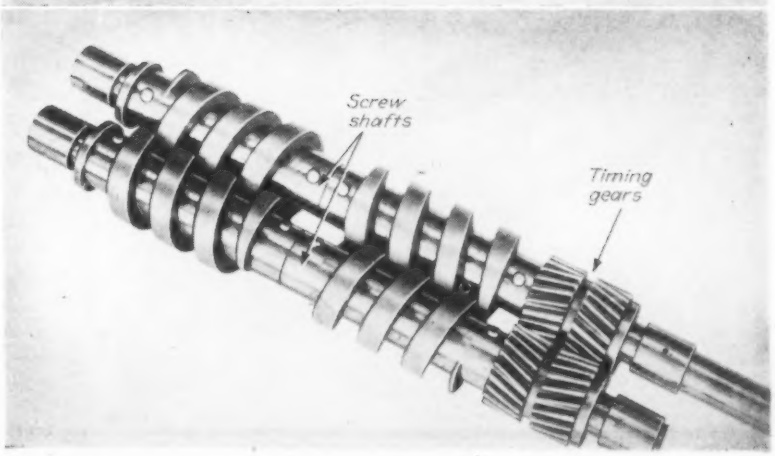
Exposure begins when the edge *A* of the outer drum opens a light path to the upper edge of the film slit. The exposure time for the film at the upper part of the slit will thus last until the edge *K* of the inner drum has moved down to cut off the light.



Blurring of the photographic image would result from the continuous film motion, from 0.002 to 0.010 in., during the short exposure time. To prevent this four glass plates ground optically flat are attached to the inner drum just inside the four slots. A light ray passing through these glass plates is refracted, and leaves the glass along a line parallel to, but offset from the original path of the ray. The angle of incidence is greater at the end of exposure. Thus the rays striking the film move downward, during exposure, an amount equal to the motion of the film.

Screw Pump Handles Thick Liquids





OPPOSED-SCREW hydraulically balanced pump has been designed, by the Sier-Bath Gear Company, to handle thick liquids of both lubricating and non-lubricating types, such as asphalt, greases, soaps, syrups and Bunker C fuel oil. Standard construction includes cast-iron housing and heads, cast-iron screws for oil, bronze screws for water and light oils, forged steel shafts, and Meehanite timing gears. Fluid enters the two outer ends of the parallel screws and flows axially to the space between the screws and out the discharge. Parallel screw shafts are fitted with herringbone timing gears that maintain correct radial and axial relation between the pumping screws. There is no frictional contact between the screws and the shafts are mounted on roller bearings.

Compressed Air Operates Gun-Chargers on B-29

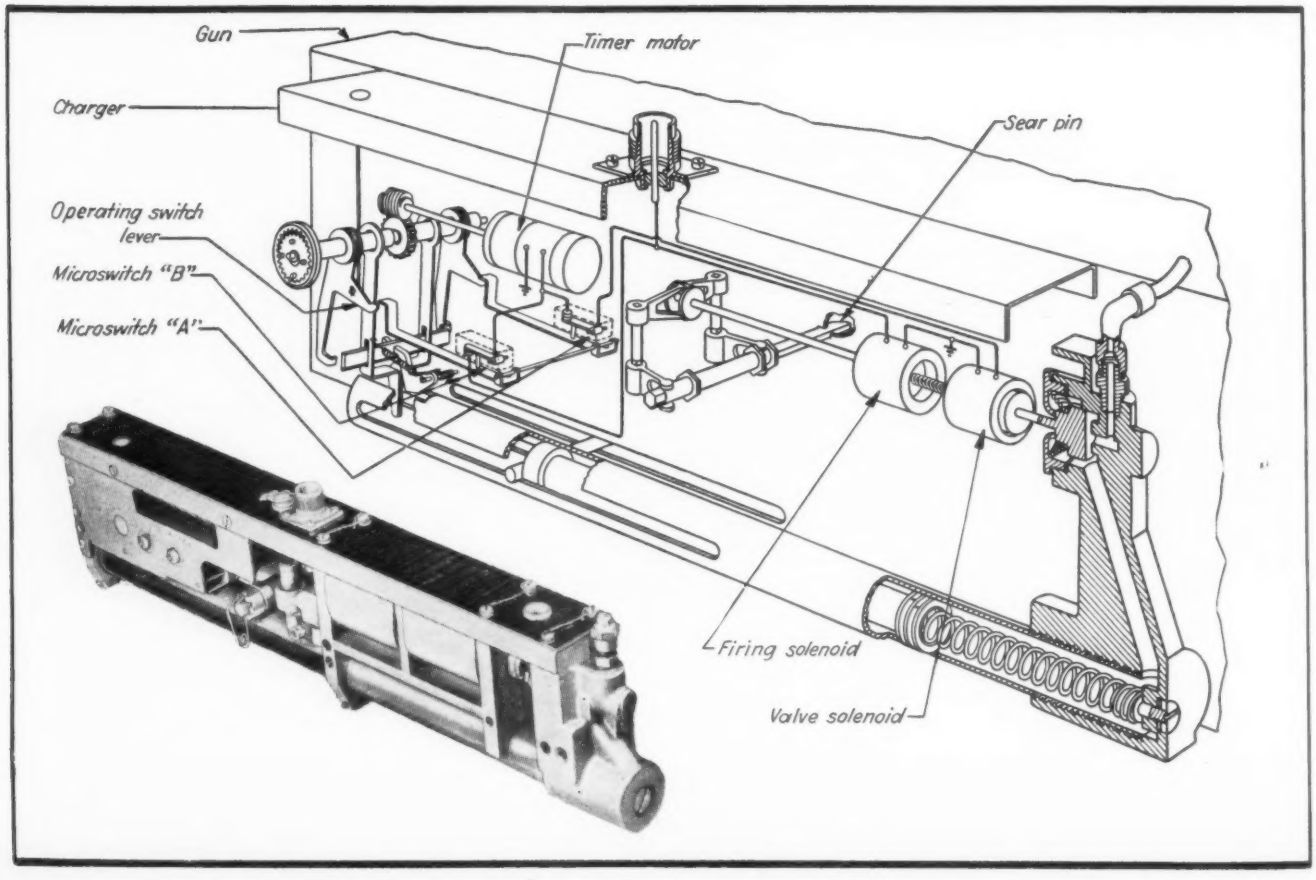
WHEN THE ARMAMENT SYSTEM for the B-29 was developed, it was decided to equip guns with automatic chargers, since the guns on the B-29 are all located a considerable distance from the gunner and he has no way of knowing when his guns are jammed. Further, the turrets are in unpressurized parts of the plane, while the gunners are in the pressurized section. Since the B-29 armament system relies on the efficient use of a comparatively small number of guns, it is essential that none of those guns should be lost to combat. The development of the charger and the engineering details of the final design are described by R. H. Breckenridge, Aeronautics and Marine Engineering Division, General Electric Company.

The charger design must meet numerous requirements. After determining that the gun has stopped firing, it must operate the gun through its normal sequence. The charging operation must be fast enough to complete the cycle during the length of a normal firing burst,—5 to 10 rounds for the 50-caliber machine gun. If the charger takes more time, it must complete a charging cycle once it has started to operate. The charger must operate under all conditions under which the gun will fire—extremes in temperature and humidity, and at any altitude. Moreover, since the charger is an emergency device, failure must not be caused by the same conditions which might cause gun failure.

Several types of charger were developed. The first charger was gas-operated. A mechanical timer measured the time between rounds while the trigger was depressed. If time exceeded a certain limit, high-pressure gas was admitted to a piston, which charged the gun.

Another charger utilized both the muzzle blast of the gun and high-pressure gas. Connection between the gas supply and the charging piston was through a pressure switch. During normal firing, the pressure of the muzzle blast kept the pressure switch in the open position. This was accomplished by trapping a portion of the muzzle blast in a hood around the muzzle of the gun. The hood was connected by a length of tubing to the pressure switch. If the gun stopped firing, the muzzle blast stopped and the switch closed. This energized a solenoid valve which admitted gas to the piston.

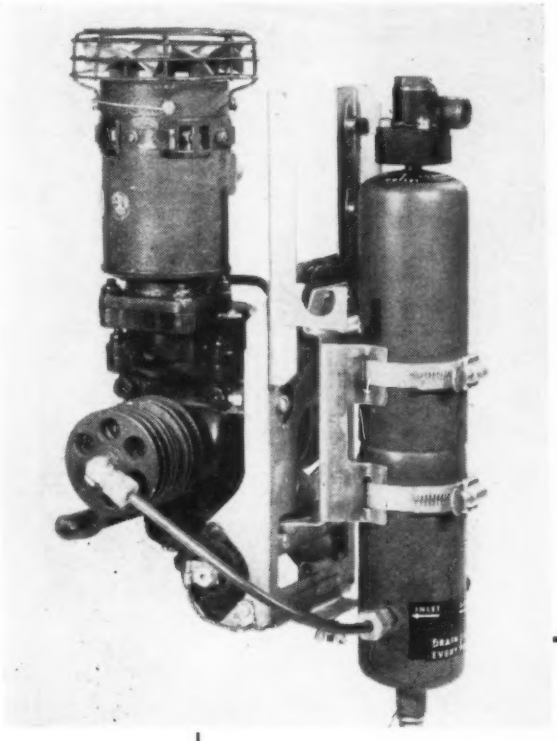
The automatic gun charger now used on all five turrets of the B-29 is air-operated, contains a firing solenoid, and has a timer driven by a tiny electric motor. The charger consists of three principal units: firing, timing, and charging. The firing unit fires the gun normally; the timing unit determines when to charge; and the charging unit charges the gun.



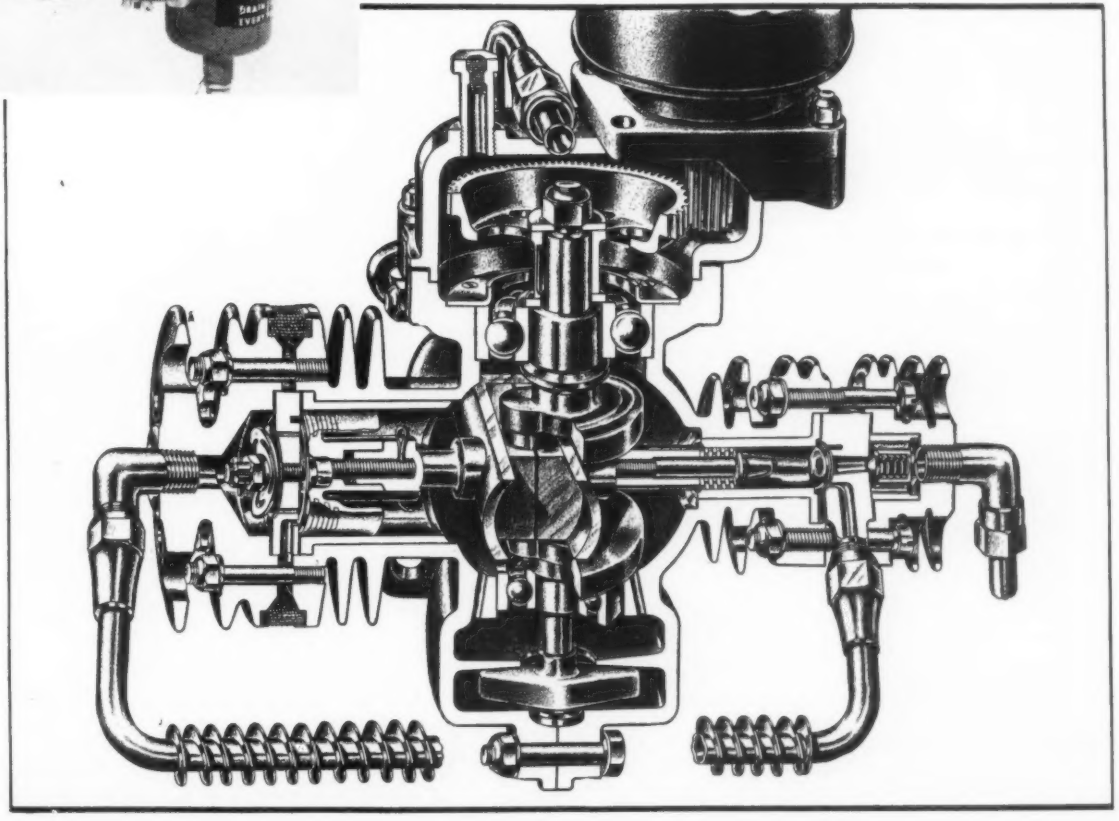
When the charger is mounted on the gun the bolt stud extends through the guide slot in the charger cylinder. The stud travels back and forth with the gun bolt and operates the timer yoke once during each firing cycle. During a charging stroke, the charging piston pushes the gun bolt to the rear by pushing against the bolt stud.

During normal operation, the firing solenoid is energized, and the sear pin moves to fire the gun. The solenoid switch lever and the operating switch lever are constantly being driven forward by the timing motor through friction clutches. Each time the gun fires, these levers are driven back, slipping the clutches. If the gun fails to fire, the solenoid switch lever is driven far enough to close switch *A*. This energizes the valve solenoid, opening the valve and admitting air to the charging piston. The bolt stud, and gun bolt, are driven to the rear. At the end of the stroke, the solenoid switch lever is pushed to the rear, which de-energizes the valve solenoid and allows the air in the cylinder to exhaust to atmosphere. The operating switch lever is not reset during a charging operation.

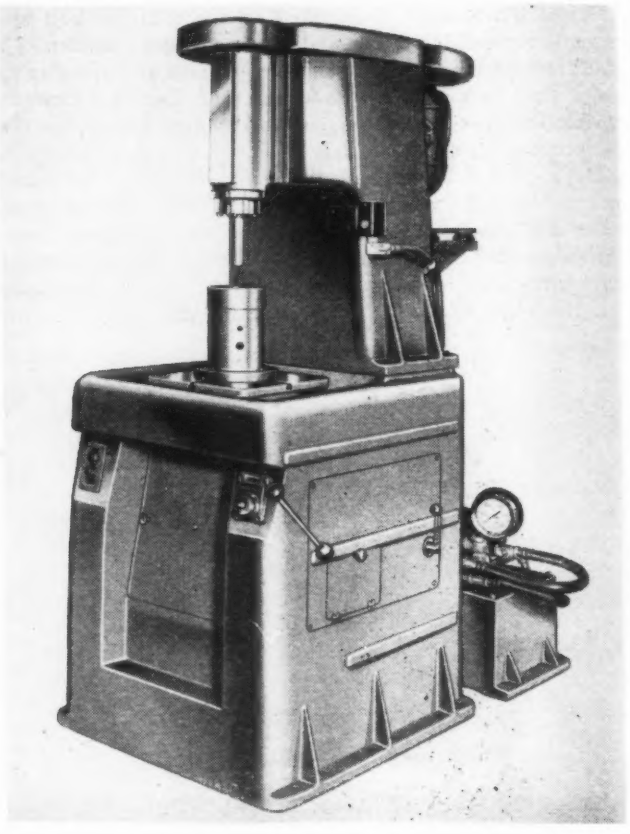
If several successive charging operations do not clear the gun so that normal firing commences, the operating switch lever operates switch *B*, which cuts the charger out of operation, except for the firing solenoid.



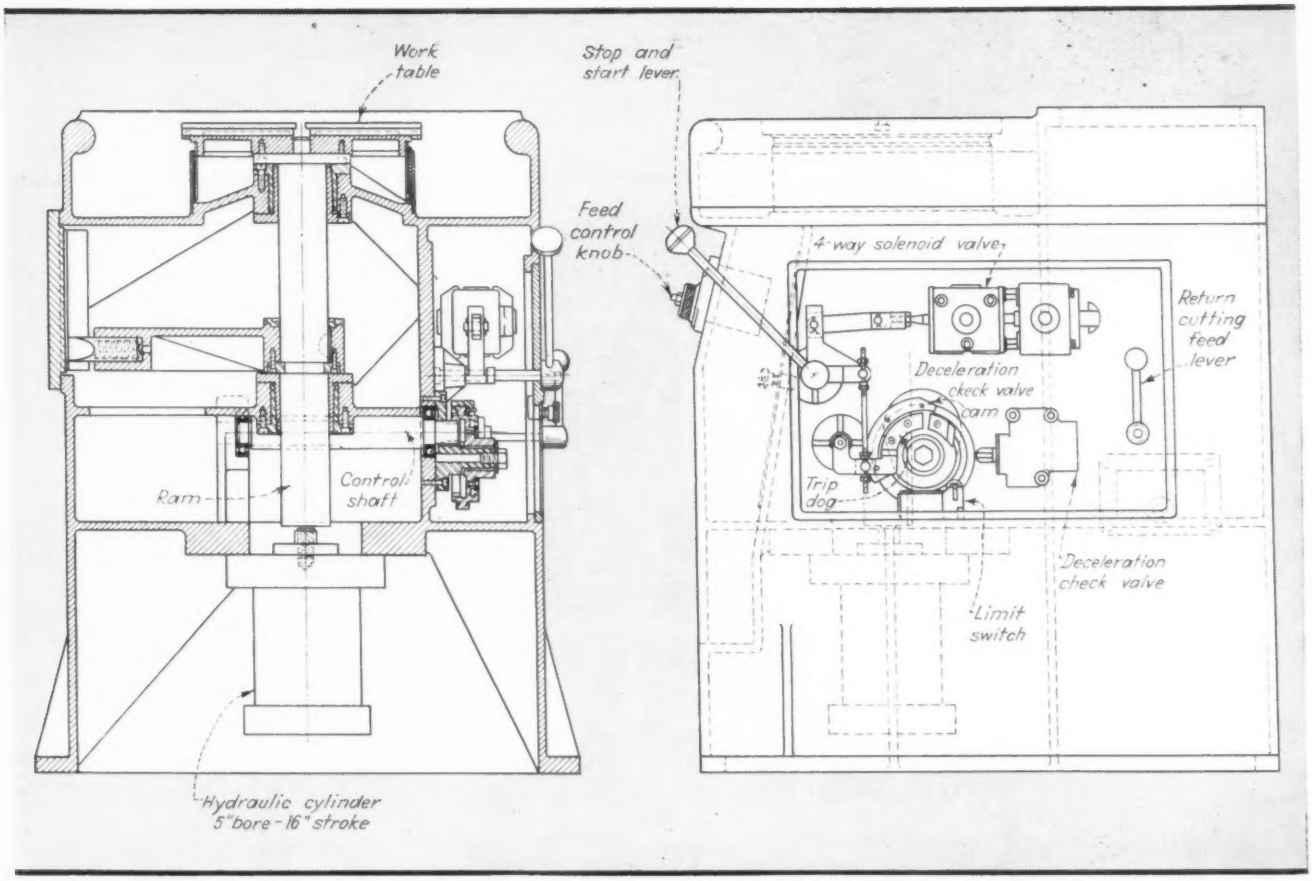
Early model chargers were gas-operated, using carbon dioxide. Available in small cylinders, it can be stored as a liquid under pressure. Because it has the disadvantage of cooling as it expands, however, a heater for the carbon dioxide container was needed to maintain temperature and consequently pressure at a high level. It was found that air at approximately 1,000 lb. per sq. in. worked well. Stored as a gas, air does not require a heater, and pressure varies much less with temperature than does carbon dioxide. A small compressor was developed to provide a constant supply of air at 1,000 lb. per sq. in. The system consists of the air compressor, a pressure tank, and an electrical control for the compressor. One such system is mounted in each gun turret. A typical installation on an upper turret is shown. The compressor is driven by a one-third hp. electric motor through a single reduction gear. It is of two-stage, scotch-yoke design operating at 2,000 r.p.m. The compressor will supply 60-cu. in. air at 1,000 lb. per sq. in. pressure to the tank in less than 4 min. at sea level, with corresponding performance at altitudes. Continuous operation is permissible at temperatures from minus 65 deg. F. to plus 160 deg. F.



Hydraulic Control Permits Feed In Two Directions



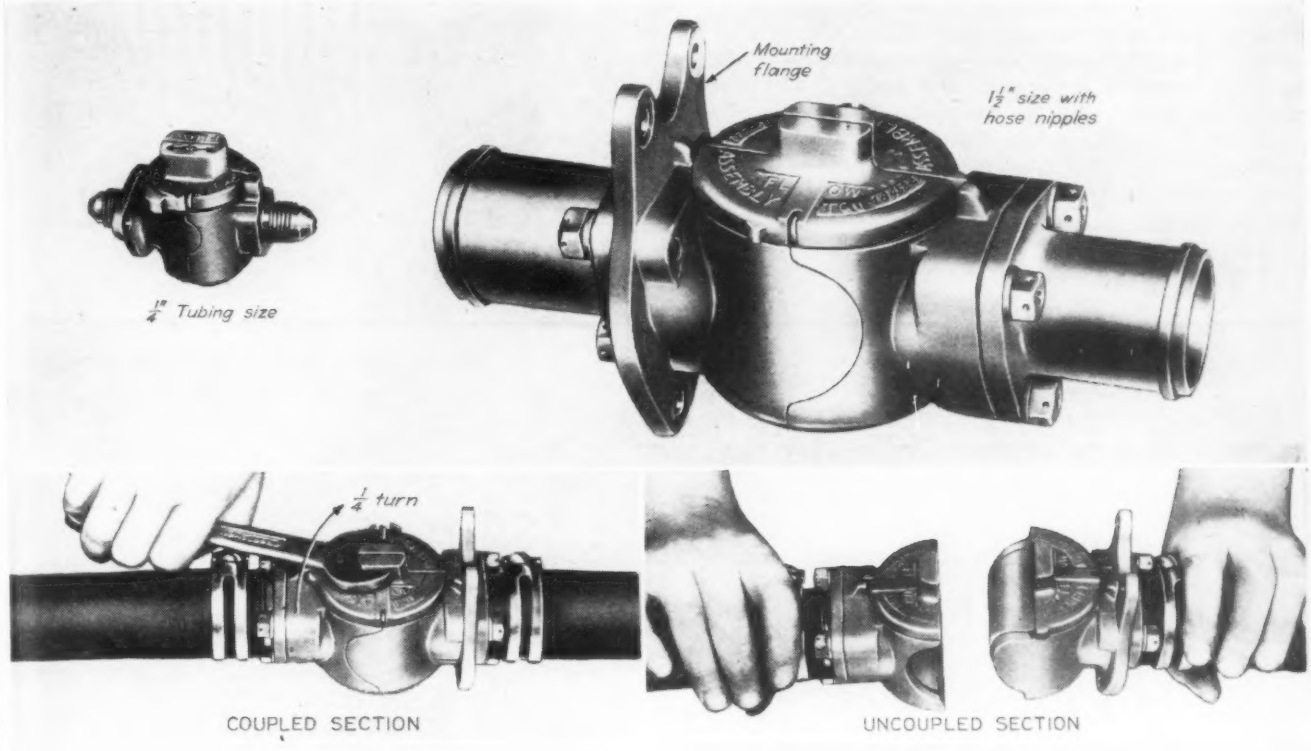
COMPACT CONSTRUCTION and convenience of operation are designed into a new vertical boring machine built by the Baush Machine Tool Company. Iron castings, heavily ribbed, minimize vibration and assure accurate spindle alignment. The spindle is the only rotating part and work is fed by a hydraulically operated table which permits boring on both the up and down feed strokes. The spindle motor is statically and dynamically balanced and will handle work up to 5 in. at 5,000 r.p.m.

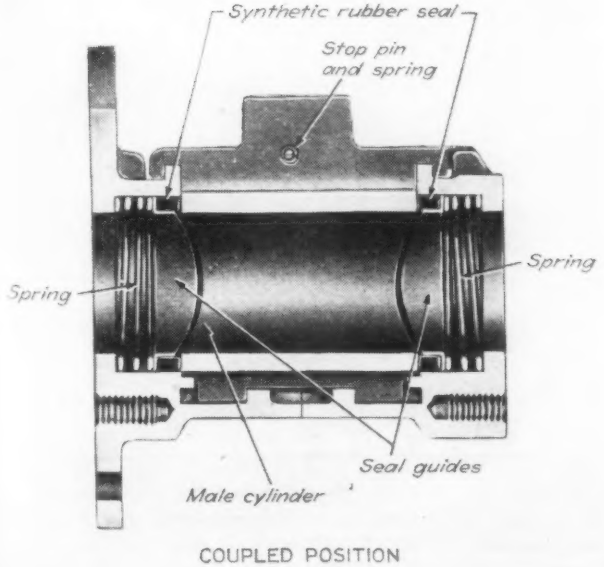


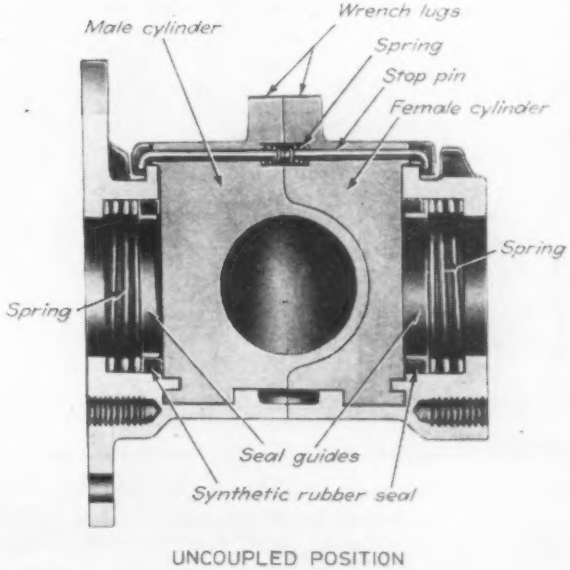
Hydraulic controls give variations in cutting feed from 3/4 to 20 in. per min. through a selector knob located on the front of the machine. The start and stop of the feed cycle is with a hand lever. Return cutting feed is obtained by a secondary lever-operated valve. Automatic control can be adjusted by trip dogs on a control shaft, driven by the ram.

Quick Disconnect Coupling Seals Against Leakage

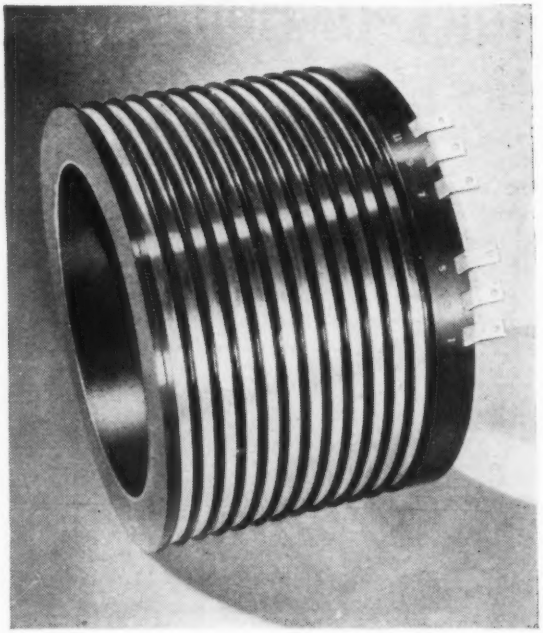
QUICK DISCONNECT COUPLINGS in the form of cylindrical type valves or cocks disconnect with a quarter turn of the wrench lugs and automatically seal both ends of the line against leakage. Each half coupling on the disconnected line can be opened to permit drainage. Entrapment of air is minimized. Couplings are interchangeable and can be adapted to any type of hose, pipe, or tubing lines. Developed by the Aircraft Accessories Division of Thompson Products, Inc., they are manufactured in sizes of ¼ to 2 in. and can be used in such fluid lines as water, hot oil, gasoline, hydraulic fluid, lubricating oil, isopropyl alcohol, and ethylene glycol. They may also be used in lines carrying air, propane, butane, carbon dioxide, and other gases. Leakage is prevented by a synthetic rubber seal held against each half of the split plug by a seal guide and spring. Stop pins prevent opening the coupling to a position resulting in unintentional disassembly.



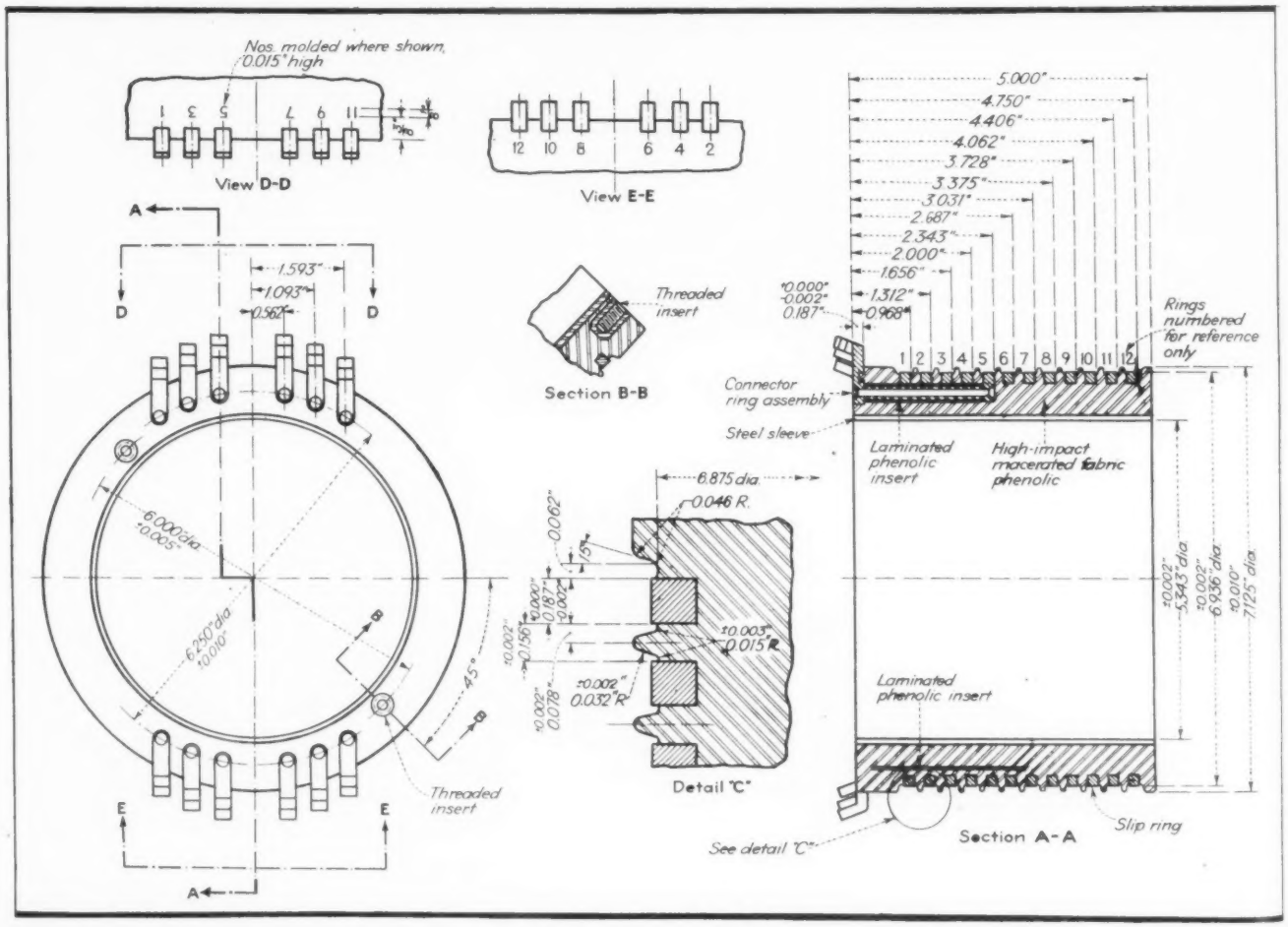




Complex Electrical Part Molded by Transfer Process



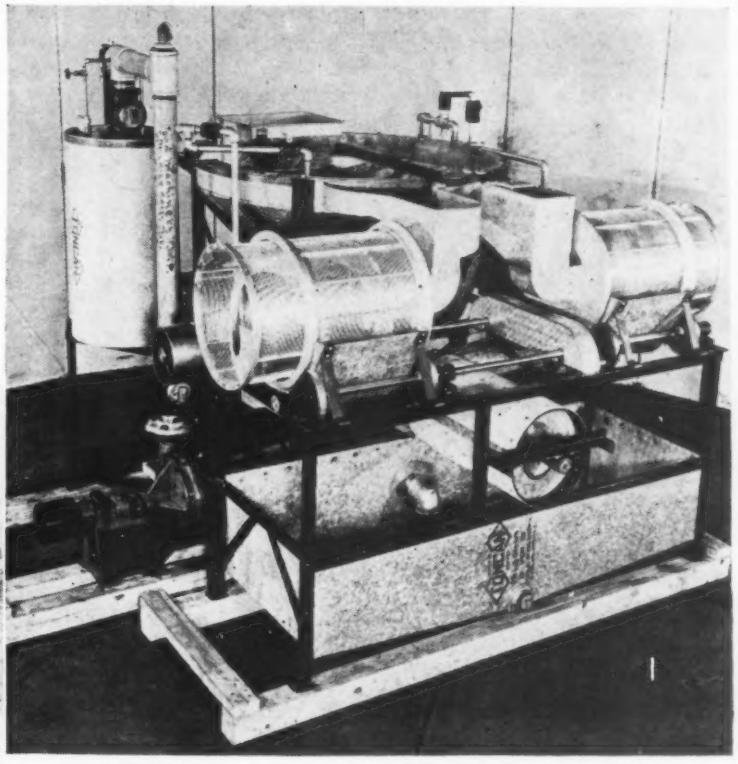
NUMEROUS METAL PARTS including slip-rings, copper leads, lugs and mounting inserts are required in this rotor for a fire control unit. Assembled units are costly, requiring much machining and fitting time. Although plastic molding offered advantages in assembly and cost, the problem was complicated by considerations of adequate strength, close dimensional tolerances, and the practicality of molding-in the numerous metal parts as inserts. Plastic Manufacturers, Inc., in cooperation with the Palmer-Bee Company have produced a satisfactory design using high-impact macerated-fabric phenolic material for strength. The transfer molding process was selected as it is well adapted to moldings wherein many inserts are required and close tolerances must be held.

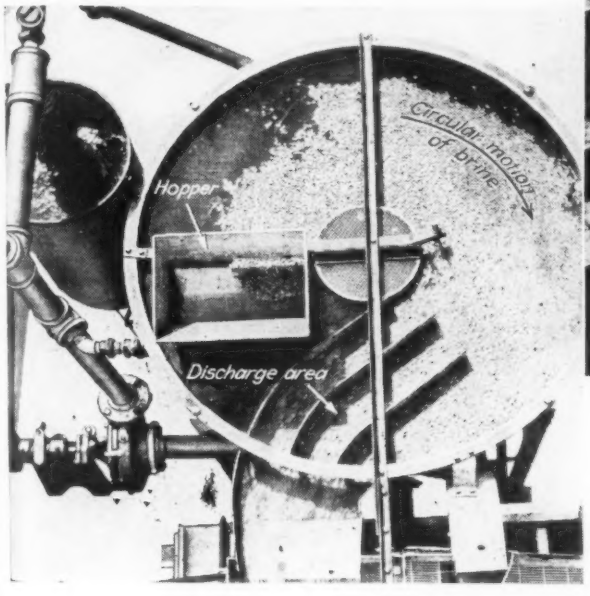


Rotor is molded around a welded and machined steel sleeve. All metal parts are assembled in the mold. Since the rings and wires are all molded in place electrical properties are improved, particularly if moisture is a problem, as there are no cracks or crevices where moisture might accumulate. Transfer molding permits close dimensional tolerances to be held on location of slip rings and other electrical parts. Hence field interchangeability is no problem.

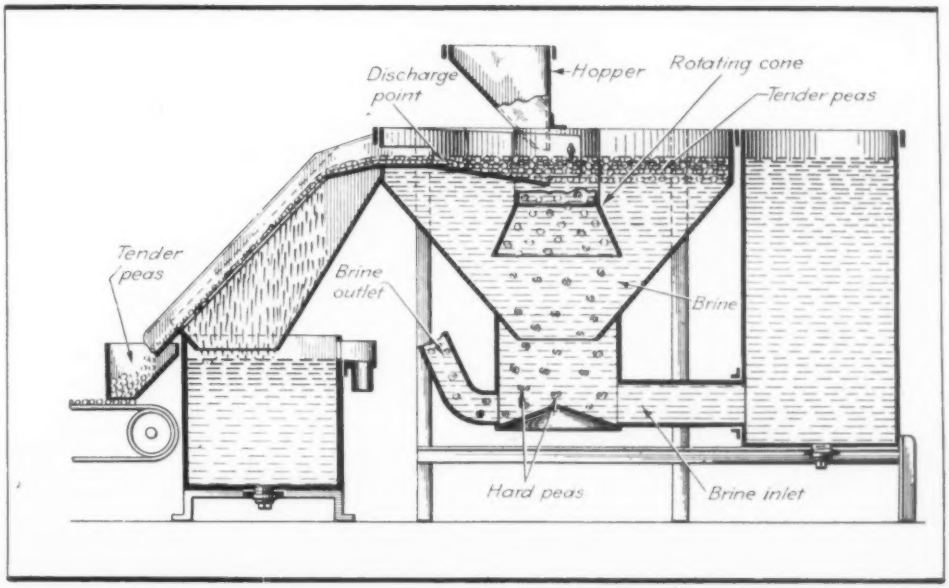
Machine Sorts and Grades Edibles By Specific Gravity

GRADING AND SORTING of peas and some other edibles by specific gravity is accomplished in a machine developed by the Sprague-Sells Division of the Food Machinery Corporation. Peas are blanched and placed in a brine solution. Since the specific gravities of tender and hard peas are different the tender peas float and the hard peas sink to the bottom.





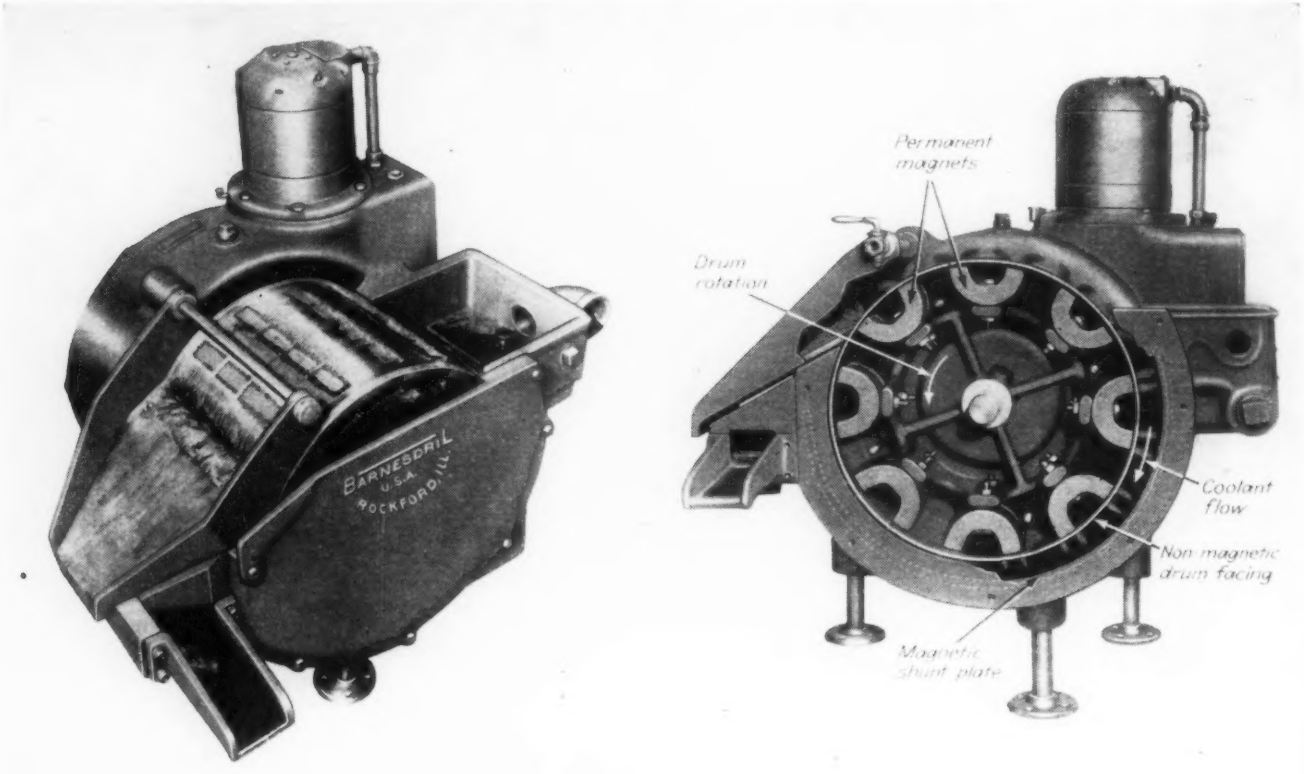
Peas enter the machine through a hopper which discharges below the surface of the brine. The circulating brine enters the separating tank through the bottom, at a tangent, giving a resulting whirl to the tankful of brine. Tender peas float to the surface and are carried around to the discharge point. Hard peas are carried to the brine outlet. Rotation of the cone in the center of the machine prevents and breaks up eddies which make peas remain in the machine longer than necessary and allow some hard peas to become mixed with the tender peas.



Magnetic Separator Removes Swarf from Coolant

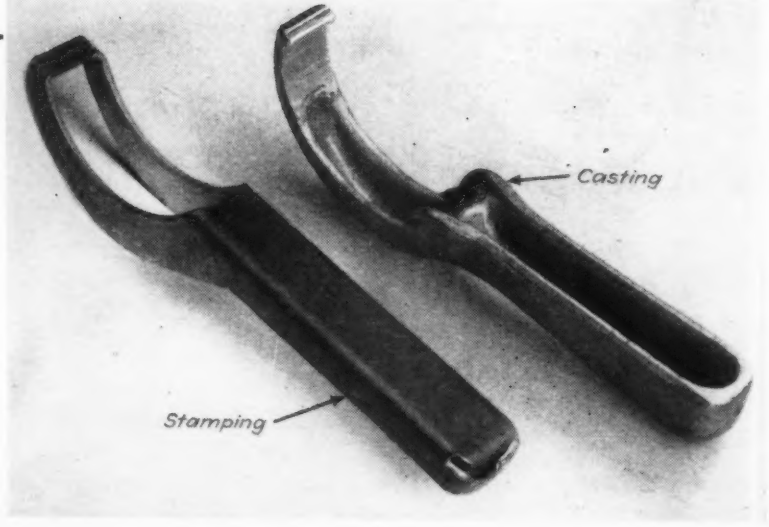
MAGNETIC SEPARATOR designed to eliminate metal and abrasive particles from the coolant used with honing machines and grinders has been developed by the Barnes Drill Company. A motor-driven drum, faced with a non-magnetic material, has permanent magnets, mounted on the inside of the drum, protruding through the non-magnetic facing. Coolant flows through the lower part of the separator in a counter direction to the slow drum rotation. Magnets attract the magnetic swarf in the coolant solution and the swarf is scraped off as the magnets pass a scraper blade.

Abrasive particles are removed along with the magnetic swarf since the inner surface of the cast iron frame forms a "magnetic shunt plate" which gives a flux path of magnetic resistance at the underside of the drum. This results in the metal swarf extending on end and forming a porous mass which strains and entraps the suspended abrasive particles.



Spanner Wrench Formerly Cast Now Stamped

REDESIGN of a special spanner wrench from a casting to a stamping has reduced wrench breakage and damage. Designed by the Dayton Rodgers Manufacturing Company, this spanner wrench is used on the collet draw-in attachment of Hardinge Brothers lathe.



For Better Technical Education

AS EARLY as 1942 educators predicted that there would be a shortage of engineers and scientifically trained men. That prophecy is already an established fact. The problem however is far more serious than even the most pessimistic had anticipated.

Over the past three decades science and engineering have made long and rapid strides. This has been reflected in manufacturing payrolls. Today the money spent for research and product development is a far greater percentage of total manufacturing costs than it was ten years ago. In some companies, the ratio has more than trebled.

Not only has the greater part played by design and research in manufacturing created a demand for more technically trained men, but the vast increase in scientific knowledge has also made it necessary for engineers to know much more than was required of them two decades ago. The fund of technical knowledge has grown so large that the usual four-year undergraduate courses are glaringly inadequate, especially in the teaching of mechanical engineering design and related subjects.

One evidence of the deficiencies in the teaching of engineering design is the long period of apprenticeship in industry required of the graduate engineer before he is able to take on responsibilities in the solution of design problems. This time could be reduced appreciably and the graduating engineer would have a far greater immediate value to industry if college courses were revised to conform to the changed needs of industry and the teachings were made more realistic and less academic. To accomplish this objective there must be far greater cooperation and association between technical universities and manufacturing companies.

Today the great need of technical universities is for qualified teachers and industrial contacts through which their faculty members can keep abreast of technical progress. Manufacturers who help the universities to meet this need will benefit both directly and indirectly.

Manufacturers can also help to improve the product of technical universities by establishing research followships, by employing college professors in a consulting capacity to help solve special problems, by employing college professors on full time during the summer months and by offering the time of executive engineers to give college lectures. Every engineer should show an active interest in the solution of the many vexing problems that now face our universities.

G. F. Nordenholt

Proportions of Elliptic Gears For Quick Return Mechanisms

F. H. MILLER and C. H. YOUNG
Cooper Union School of Engineering

Determination of the proportions of two elliptic gears of the same size to produce a specified quick return ratio. The relationship between the maximum velocity ratio and the quick return ratio is also investigated in addition to some associated kinematic relations. A typical elliptic gear design problem is included.

WHEN a variable velocity ratio is required throughout a revolution of a machine, the motion can often be obtained with advantage by means of elliptic gears. The simplicity in arrangement of parts has promoted the use of elliptic gears for quick-return motions in machines such as planers, shapers, slotters and shears which perform their work intermittently with the stroke of a reciprocating member.

Elliptic gears are often more desirable than crank and rod mechanisms, particularly at high speeds, because dynamic unbalance caused by rotating unbalanced masses can be eliminated more readily by suitable counterbalances on the shafts than by proportioning linkages to obtain minimum unbalance.

The problem of finding the proportions of two elliptic gears to suit a specified quick-return ratio is possible of solution when the gears are the same size and shape.

The pitch lines of two equal elliptic gears with their large diameters in line are shown in Fig. 1. One ellipse, the driver D_1, rotates about a focus F_1 with a constant angular velocity ω_1. The driven ellipse D_2 thereby rotates about a corresponding focus F_2 with varying angular velocity ω_2. The dimensions of the gears are designated by the conventional notation of analytic geometry.

a = semi-major axis OA
b = semi-minor axis OB
$c = (a^2 - b^2)^{1/2}$ = focal distance OF_1
$e = c/a$ = eccentricity
b^2/a = half latus rectum F_2C

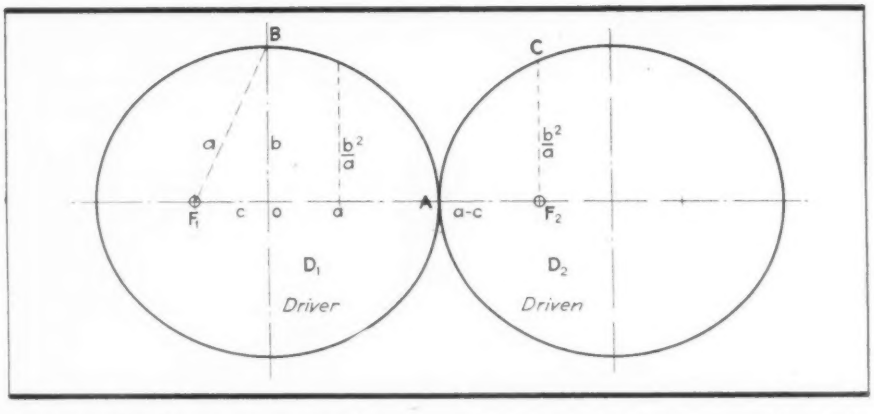


Fig. 1—Pitch lines and major dimensions of two equal elliptic gears with their large diameters in line.

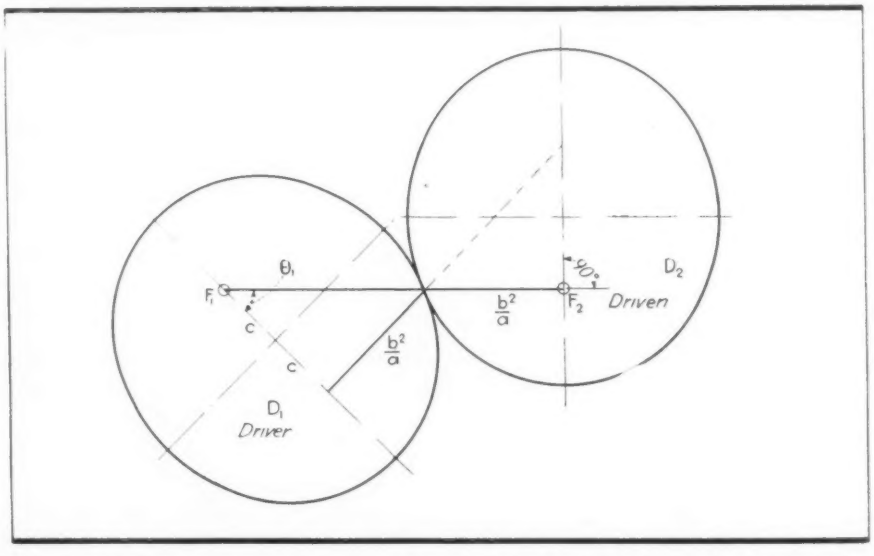


Fig. 2—Position of gears when the driven gear has rotated through a right angle.

If the driver D_1 rotates through an angle θ_1 about F_1 to produce a 90 deg. rotation of D_2 about F_2, as indicated in Fig. 2, then a rotation of the driver from an angular displacement θ_1 on one side of the initial position to an angular displacement θ_1 on the other side corresponds to a rotation of half a revolution of D_2 about F_2. Consequently the remainder of the complete revolution

$c = (a^2 - b^2)^{\frac{1}{2}}$ = focal distance OF_1

corresponds to the other half revolution about F_2. The quick return ratio r for these elliptic gears is then expressed by

$$r = \frac{360 - 2\theta_1}{2\theta_1} = \frac{180 - \theta_1}{\theta_1} \qquad (1)$$

$$\theta_1 = \frac{180}{r + 1}, \text{ deg.} \qquad (2)$$

From Fig. 2 with the aid of the relations

$$\sin \theta_1 = \frac{b^2/a}{[(2c)^2 + (b^2/a)^2]^{1/2}}$$

$$\text{and } c^2 = a^2 - b^2$$

it can be shown that

$$\frac{b}{a} = \sqrt{\frac{2 \sin \theta_1}{1 + \sin \theta_1}} \qquad (3)$$

Equation (3), together with Equation (2) for θ_1 yields

$$\frac{b}{a} = \sqrt{\frac{2 \sin [180/(r+1)]}{1 + \sin [180/(r+1)]}} \qquad (4)$$

from which one can easily find the ratio of minor to major axis for a specified quick return ratio r. In Fig. 3 the values of b/a are plotted against values of r ranging from 1 to 10.

For the range of values of r between 1.5 and 4.5, an equation for a straight line that closely fits the corresponding portion of the curve of Fig. 3 is easily obtained by the method of least squares; the resulting linear equation is

$$\frac{b}{a} = 1.063 - 0.0505r \qquad (5)$$

An equation which evaluates the eccentricity e of the ellipses in terms of r can readily be developed.

$$e^2 = \frac{c^2}{a^2} = \frac{a^2 - b^2}{a^2} = 1 - \frac{b^2}{a^2}$$

Inserting the value of b^2/a^2 as given by Equation (4), then simplifying and transforming

$$e = \tan \left[\frac{45\,(r-1)}{r+1}\right] \qquad (6)$$

For a given pair of ellipses, the maximum velocity ratio M will be obtained when the gears are in the position shown in Fig. 1. If ω_1 and ω_2 are the angular velocities of the driver and driven gears respectively, then, since the linear velocity of the point of tangency A must be the same for both gears,

$$\omega_1 (a + c) = \omega_2 (a - c)$$

or

$$M = \frac{\omega_2}{\omega_1} = \frac{a+c}{a-c} = \frac{1 + c/a}{1 - c/a} = \frac{1+e}{1-e}$$

Inserting for e its value from Equation (6)

$$M = \frac{1 + \tan \left[\frac{45(r-1)}{r+1}\right]}{1 - \tan \left[\frac{45(r-1)}{r+1}\right]} \qquad (7)$$

Since

$1 = \tan 45$ deg.

Equation (7) can be expressed as

$$M = \frac{\tan 45 + \tan \left[\frac{45(r-1)}{r+1}\right]}{1 - \tan 45 \tan \left[\frac{45(r-1)}{r+1}\right]}$$

$$= \tan \left[45 + \frac{45(r-1)}{r+1}\right]$$

$$= \tan \left[\frac{90r}{r+1}\right] \qquad (8)$$

Using Equation (8), the maximum velocity ratio M is plotted in Fig. 4 against values of the quick return ratio r. The variation of M with r is almost linear. The method of least squares yields as the best linear fit between values of 1.5 and 4.5 for r,

$$M = 0.3793 + 0.675r \qquad (9)$$

As the angular displacement θ from the initial position of Fig. 1 increases, the velocity ratio ω_2/ω_1 decreases toward the minimum value $1/M$ which corresponds to θ equal to 180 degrees.

The angular displacement θ_c for which the velocity ratio ω_2/ω_1 is equal to unity will be determined next. As the gear D_1 rotates from the position in Fig. 1, the focal radius from F_1 to the point of contact will exceed the radius from F_2 until the ellipses are tangent at the extremities of their minor axes, when each focal radius is equal to a. The critical angle θ_c is therefore equal to the angle AF_1B in Fig. 1, whence

$$\cos \theta_c = \frac{c}{a} = e$$

or from Equation (6)

$$\cos \theta_c = \tan \left[\frac{45(r-1)}{r+1}\right] \qquad (10)$$

The values of θ_c corresponding to values of r from 1 to 10 are plotted in Fig. 5. Points below the curve then represent the values of θ for which the angular velocity ω_2 of the driven gear exceeds ω_1 of the driver; values of θ for each value of r such that ω_2 is less than ω_1 are represented by points above the curve.

An example will illustrate the procedure in proportioning a pair of equal

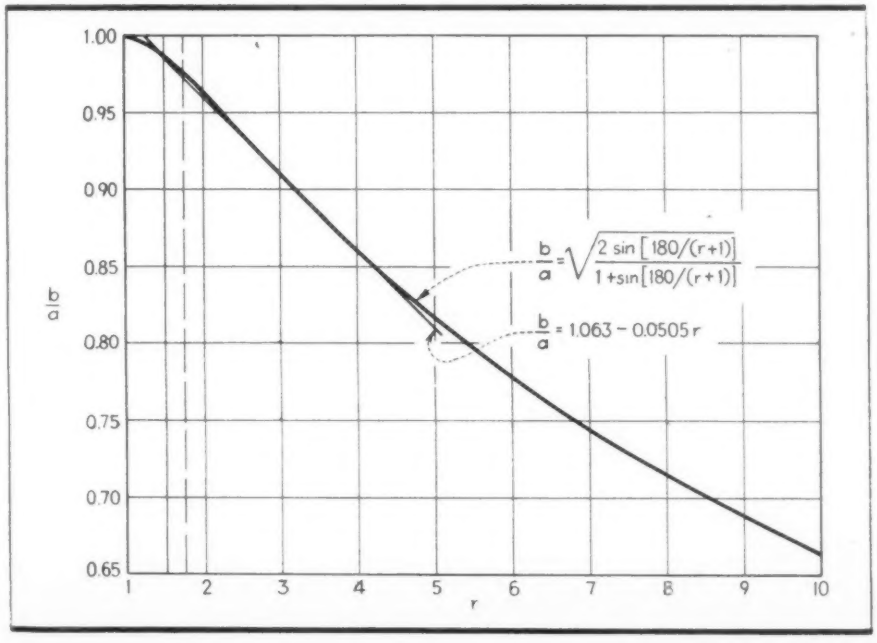


Fig. 3—Ratio of minor to major axis for a range of quick return ratios.

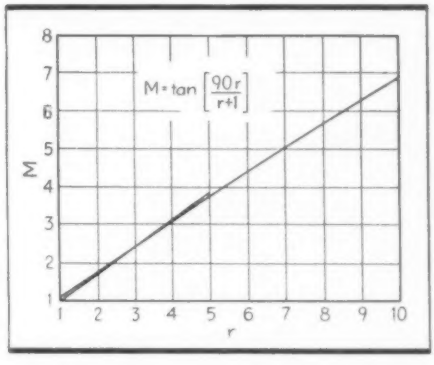


Fig. 4—Maximum velocity ratio plotted for different values of quick return.

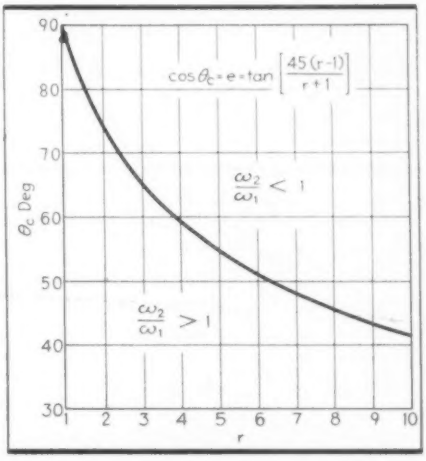


Fig. 5—Values of critical angle plotted for different values of quick return.

elliptic gears for a quick return mechanism.

EXAMPLE. Two shafts at a center to center distance of 3¾ in. are to be connected by elliptic gears that will produce a quick return ratio r equal to 1.75. Approximately 2 hp. will be transmitted and the driver shaft is to rotate at a constant angular velocity of 900 r.p.m. Other design characteristics indicate that each shaft should be 1 in. in diameter to provide adequate stiffness.

From Equation (2)

$$\theta_1 = \frac{180}{2.75} = 65.45 \text{ deg.}$$

whence

$$2\theta_1 = 131 \text{ deg.}$$

and

$$360 - 2\theta_1 = 229 \text{ deg.}$$

Since the major axis, of length $2a$, must equal the distance between shafts,

$$a = 1.875 \text{ in.}$$

Equation (3) yields

$$\frac{b}{a} = \sqrt{\frac{2 \sin 65.45}{1 + \sin 65.45}} = \sqrt{\frac{2 \times 0.9086}{1 + 0.9086}} = 0.976$$

whence

$$b = 0.976 \times 1.875 = 1.83 \text{ in.}$$

Alternatively, Equation (5) gives

$$\frac{b}{a} = 1.063 - 0.0505 \times 1.75 = 0.975$$

which leads to nearly the same value for b, namely 1.83 inches.

Also the length of the focal distance

$$c = \sqrt{a^2 - b^2} = \sqrt{(1.875)^2 - (1.83)^2} = 0.408 \text{ in.}$$

so that

$$a - c = 1.467 \text{ in.}$$
$$a + c = 2.283 \text{ in.}$$

These two figures represent the distances from the point of tangency A, Fig. 1, to the centers of the shafts. Moreover, from the relation e equals c/a, or from Equation (6),

$$e = 0.218$$

and the half latus rectum is

$$\frac{b^2}{a} = \frac{(1.83)^2}{1.875} = 1.79 \text{ in.}$$

The ellipses shown in Fig. 6 conform to these calculations.

For these ellipses, the maximum velocity ratio from Equation (8) is

$$M = \tan\left[\frac{90 \times 1.75}{2.75}\right] = \tan 57.27 \text{ deg.} = 1.556$$

or, from Equation (9),

$$M = 0.3793 + 0.675 \times 1.75 = 1.560$$

The maximum instantaneous angular velocity of gear D_2 is approximately

$$900 \times 1.56 = 1,400 \text{ r.p.m.}$$

The minimum instantaneous angular velocity of gear D_2 is

$$900/1.56 = 577 \text{ r.p.m.}$$

The critical angle θ_c is given by

$$\cos \theta_c = e = 0.218$$
$$\theta_c = 77.4 \text{ deg.}$$

Thus, the velocity ratio ω_2/ω_1 will be greater than unity for 77.4/180, or 0.43, of a revolution of the driver D_1, and will be less than unity for the remaining 57 percent of the revolution.

Calculations for tooth size to determine the pitch and face width to satisfy the dynamic and wear load conditions, for steel gears having a Brinell number of 400, give the circular pitch as 0.5236 in. and the face width as 1 inch.

The perimeter L of the pitch ellipse of each gear is given by

$$L = 4aE(e) = 4a \int_0^{\pi/2} \sqrt{1 - e^2 \sin^2 \phi}\, d\phi \quad (11)$$

where $E(e)$ is the complete elliptic integral of the second kind, with modulus e. Hence

$$L = 4 \times 1.875\ E(0.218) = 4 \times 1.875 \times 1.552 = 11.64 \text{ in.}$$

Consequently the number of teeth in each gear theoretically would be

$$\frac{11.64}{0.5236} = 22.22 \text{ teeth}$$

Since gears cannot have a fractional part of a tooth, it is necessary to adjust the size of the ellipses. With 22 teeth the perimeter of the pitch ellipse must be

$$L' = 22 \times 0.5236 = 11.52 \text{ in.}$$

whence Equation (11) yields

$$a' = \frac{L'}{4E(e)} = \frac{11.52}{4 \times 1.552} = 1.856 \text{ in.}$$

Thus the new major axis will be $2a'$ equals 3.712 in., only 0.038 in. less than that desired. Since the specified proportions must be retained the minor axis $2b'$ is

$$3.712 \times 0.976 = 3.623 \text{ in.}$$

These gears with the shafts and hubs are shown in Fig. 6 with the teeth in contact at the point of tangency. A standard 6 diametral pitch cutter would be used to cut these teeth on a milling machine. If the gears were to be made in large enough quantities, a special jig would be desirable to facilitate the milling operation.

It would probably not be necessary to adjust the distance between shafts by the small amount of 0.038 in., so that in this instance no further calculations are needed. Under other conditions a larger circular pitch might be required, if so, this might entail too small a number of teeth, so that larger ellipses would be needed and a consequent adjustment of the distance between shafts.

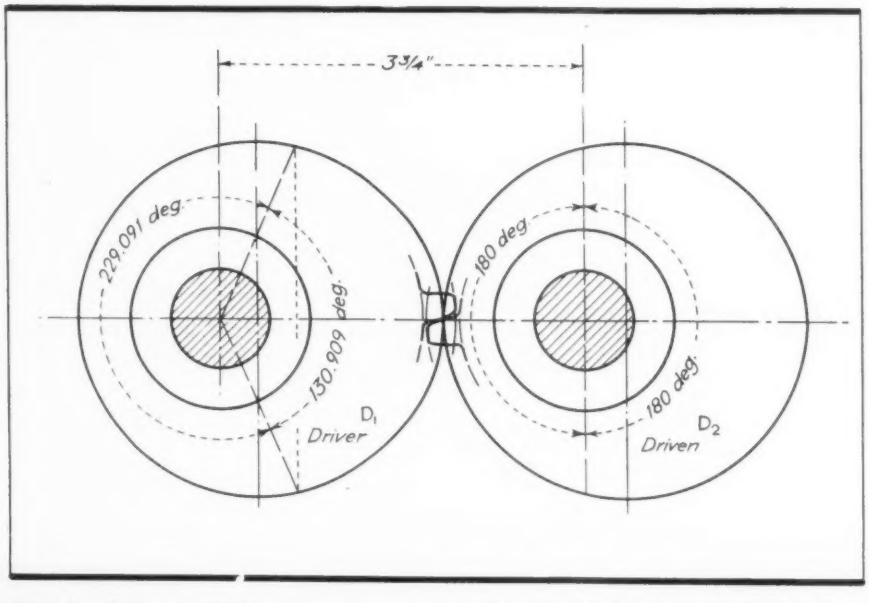


Fig. 6—Pair of elliptic gears on a center distance of 3¾ in., designed for a quick return ratio of 1.75.

Release and Control Procedures For Engineering Drawings

JAMES E. THOMPSON
Chief Engineer, Booth Manufacturing Corporation

Drawing release procedures applicable to layout, text and manufacturing drawings are discussed and illustrated. Typical forms for assignment records, release requests, job tickets, and drawing status records are shown.

THE function of the release group within the engineering department is to obtain required authorization, checking, corrections and approval of all drawings before prints are released to the factory. After the drawing is processed, prints are obtained and forwarded to the correct destinations. Records maintained by the release group show the status of each drawing, and the location of each print.

The basic step-by-step operation of the drawing release procedure is shown in Fig. 1. Each completed drawing is given by the draftsman to his group supervisor, who checks new drawings for functional designs, and changed drawings for correct execution of the change. Drawings meeting with the supervisor's satisfaction are then forwarded to the release group for processing through the checking and approval system. Each drawing is recorded and forwarded to the engineering checking group who check for production design, accuracy of change incorporation, dimensional exactness, correctness of material and proess data, and conformance to drafting standards. Incorrect drawings are returned to the draftsman. When all errors are corrected each drawing is signed by the checker, and returned to Release for forwarding to the special checkers.

These special checkers include stress analysts who examine each drawing to insure that all parts have necessary strength; weight engineers who ascertain the weight of each part and make certain that no part is heavier than necessary for the required strength and rigidity. A production engineer may check each drawing to determine the practicability of manufacturing the parts. A tool engineer may examine the drawings to make certain that the design does not require unnecessarily complicated tooling.

The number of special checkers is governed by the nature of the product to meet the needs of the engineering department. Drawings are returned to the release group by each special checker after the required corrections have been made. Release forwards each to the next special checker, and records the location of the drawings in the system.

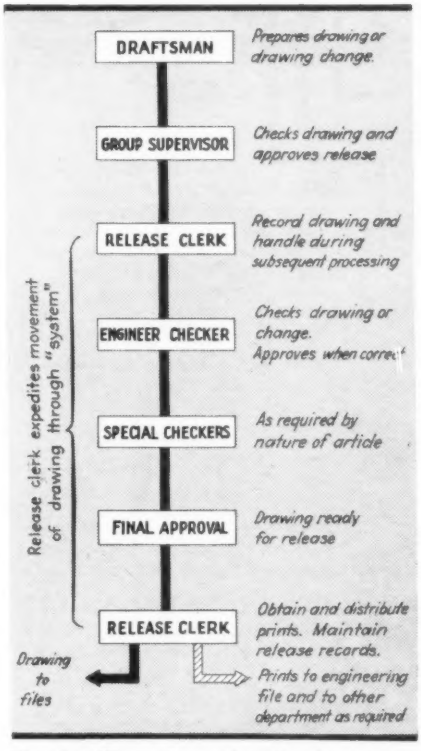

DRAFTSMAN
Prepares drawing or drawing change.
GROUP SUPERVISOR
Checks drawing and approves release
RELEASE CLERK
Record drawing and handle during subsequent processing
ENGINEER CHECKER
Checks drawing or change. Approves when correct
SPECIAL CHECKERS
As required by nature of article
FINAL APPROVAL
Drawing ready for release
RELEASE CLERK
Obtain and distribute prints. Maintain release records.
Release clerk expedites movement of drawing through "system"
Drawing to files
Prints to engineering file and to other department as required

Fig. 1—Flow chart showing basic procedure for releasing engineering drawings.

After final check, drawings are forwarded for final engineering approval. This is usually a function of the chief project engineer or chief engineer with new drawings, and of the chief draftsman or project engineer with changed drawings. The release group obtains the necessary quantities and kinds of prints from each approved drawing, forwards these prints to their destinations, and sends the drawing to engineering files. Records maintained by Release show the destination of each print.

The release procedure will vary somewhat according to the nature of the drawing. There are three basic functional types of drawings prepared in the engineering department: layout drawings; test drawings; and manufacturing drawings. Layout drawings define basic structural or mechanical designs, and serve as the basis of subsequent manufacturing drawings. Only in rare cases are other than engineering reference prints made from layout drawings. Because these serve as the basis for future manufacturing drawings, positive control must be maintained to insure that all layout drawings are properly checked, approved and recorded.

Test drawings are prepared when it is desired to make a mechanism or structure for functional test, structural test or mock-up purposes. The release of these drawings varies only in that the required prints are few in number, and bear special identification to preclude the possibility of use for manufacture.

Manufacturing drawings form the large majority of the drawings released by an engineering department. They are prepared to provide manufacturing instructions for parts to be assembled to form complete articles; including production, experimental, spare and service units—but excluding test and mock-up parts. The detail release procedure is practically the same, whether the drawing is for experimental or production articles. It is equally important to check and approve both experimental and production drawings. The release of manufacturing drawings will be considered first, as the procedures for releasing layout and test drawings are modifications of the basic procedure.

Releasing Manufacturing Drawings

Detail procedure for the release of manufacturing drawings is shown at Fig. 2. The method is used by a large

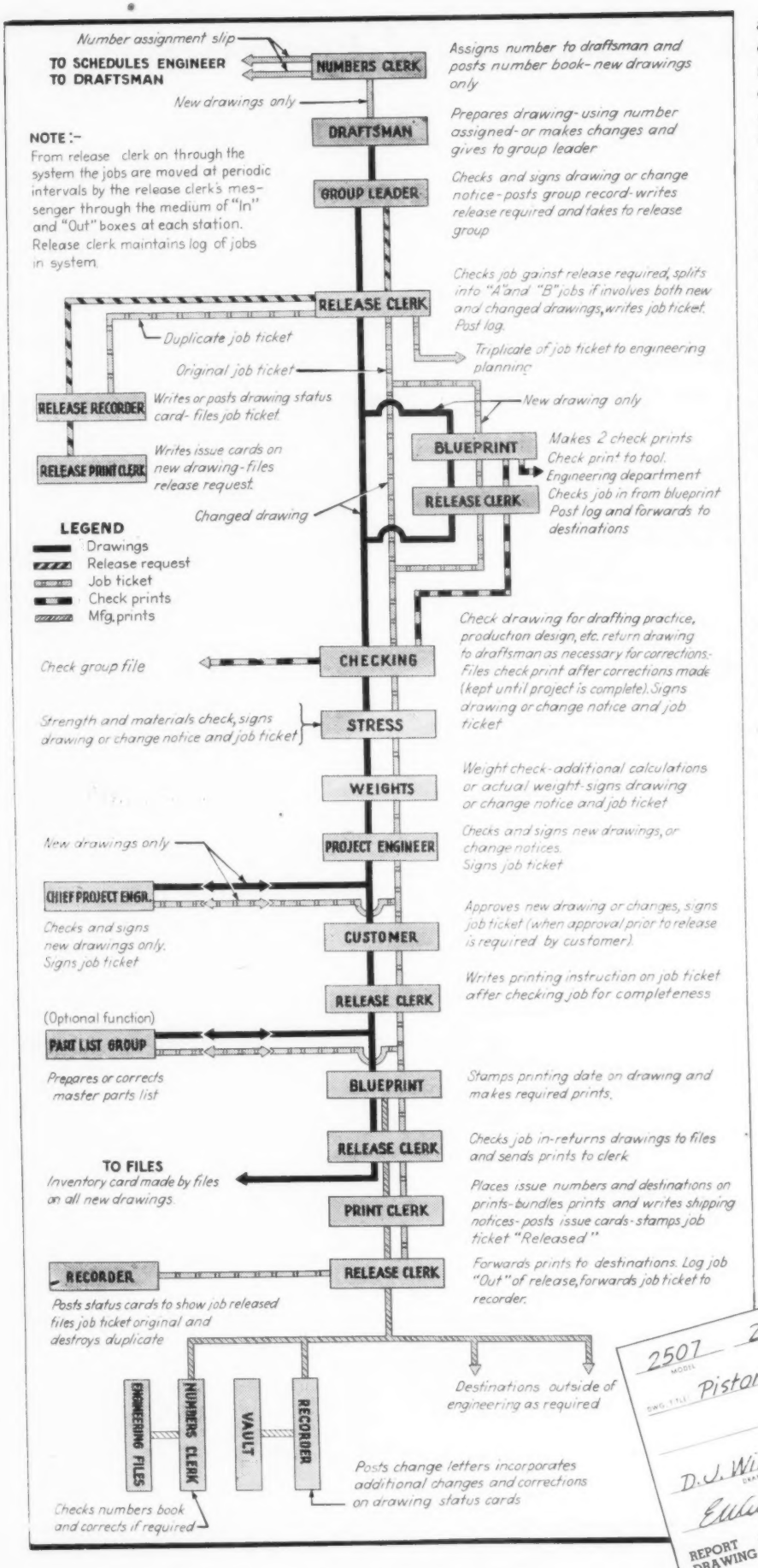

Number assignment slip
TO SCHEDULES ENGINEER
TO DRAFTSMAN
NUMBERS CLERK
Assigns number to draftsman and posts number book- new drawings only
New drawings only
DRAFTSMAN
Prepares drawing- using number assigned- or makes changes and gives to group leader
NOTE:-
From release clerk on through the system the jobs are moved at periodic intervals by the release clerk's messenger through the medium of "In" and "Out" boxes at each station. Release clerk maintains log of jobs in system.
GROUP LEADER
Checks and signs drawing or change notice- posts group record- writes release required and takes to release group
Checks job against release required, splits into "A" and "B" jobs if involves both new and changed drawings, writes job ticket. Post log.
RELEASE CLERK
Duplicate job ticket
Triplicate of job ticket to engineering planning
Original job ticket
RELEASE RECORDER
Writes or posts drawing status card- files job ticket
New drawing only
BLUEPRINT
Makes 2 check prints
Check print to tool.
Engineering department
RELEASE PRINT CLERK
Writes issue cards on new drawing- files release request.
RELEASE CLERK
Checks job in from blueprint
Post log and forwards to destinations
Changed drawing
LEGEND
Drawings
Release request
Job ticket
Check prints
Mfg. prints
Check drawing for drafting practice, production design, etc. return drawing to draftsman as necessary for corrections.- Files check print after corrections made (kept until project is complete). Signs drawing or change notice and job ticket
Check group file
CHECKING
Strength and materials check, signs drawing or change notice and job ticket
STRESS
Weight check- additional calculations or actual weight- signs drawing or change notice and job ticket
WEIGHTS
Checks and signs new drawings, or change notices.
Signs job ticket
New drawings only
PROJECT ENGINEER
CHIEF PROJECT ENGR.
Checks and signs new drawings only.
Signs job ticket
Approves new drawing or changes, signs job ticket (when approval prior to release is required by customer).
CUSTOMER
Writes printing instruction on job ticket after checking job for completeness
RELEASE CLERK
(Optional function)
PART LIST GROUP
Prepares or corrects master parts list
Stamps printing date on drawing and makes required prints.
BLUEPRINT
Checks job in- returns drawings to files and sends prints to clerk
RELEASE CLERK
TO FILES
Inventory card made by files on all new drawings.
Places issue numbers and destinations on prints- bundles prints and writes shipping notices- posts issue cards- stamps job ticket "Released"
PRINT CLERK
Forwards prints to destinations. Log job "Out" of release, forwards job ticket to recorder.
RECORDER
RELEASE CLERK
Posts status cards to show job released files job ticket original and destroys duplicate
Destinations outside of engineering as required
ENGINEERING FILES
NUMBERS CLERK
VAULT
RECORDER
Posts change letters incorporates additional changes and corrections on drawing status cards
Checks numbers book and corrects if required

Fig. 2—Typical drawing release procedure suitable for aircraft factory.

aircraft company, having an engineering department of over 300 employees, and simultaneously working on several models. This plan is adaptable to any large engineering department engaged in the design of a complex product.

The control of drawing release actually begins before the drawing is prepared, through regulation of drawing numbers. This is a function of the engineering planning group, who maintain master numbers books for each model. As soon as a draftsman ascertains the nature of a new drawing, a number is obtained from the numbers clerk in Planning. The numbers clerk determines that the drawing title is correct, assigns the number, and issues the draftsman the original copy of a "Drawing Number Assignment" slip similar to that shown at Fig. 3. A duplicate copy of this form is forwarded to the Scheduling unit of Planning as notification that work is about to begin on the drawing.

The new drawing number and other pertinent data is posted in the master numbers book for the model affected. This record is kept on a form similar to that shown at Fig. 4. This form is printed on vellum paper to permit daily issuance of revised numbers book pages to the checking group, production planning department and others interested in the preparation of new drawings. The numbers book shows the models each drawing is effective upon. It also indicates if the new drawing will replace an existing drawing, and notes opposite the existing drawing entry that it will be replaced by the new drawing.

The original copy of the Drawing Number Assignment slip accompanies the completed drawing to the engineering checking group. The drawing is checked against the slip, and both are checked against the master numbers

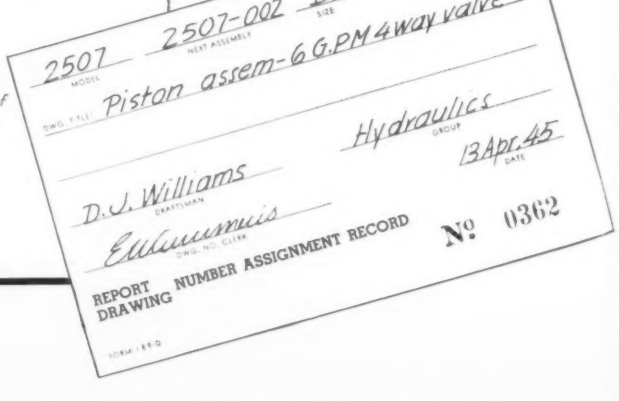


Fig. 3—Drawing number assignment slip, prepared in duplicate.

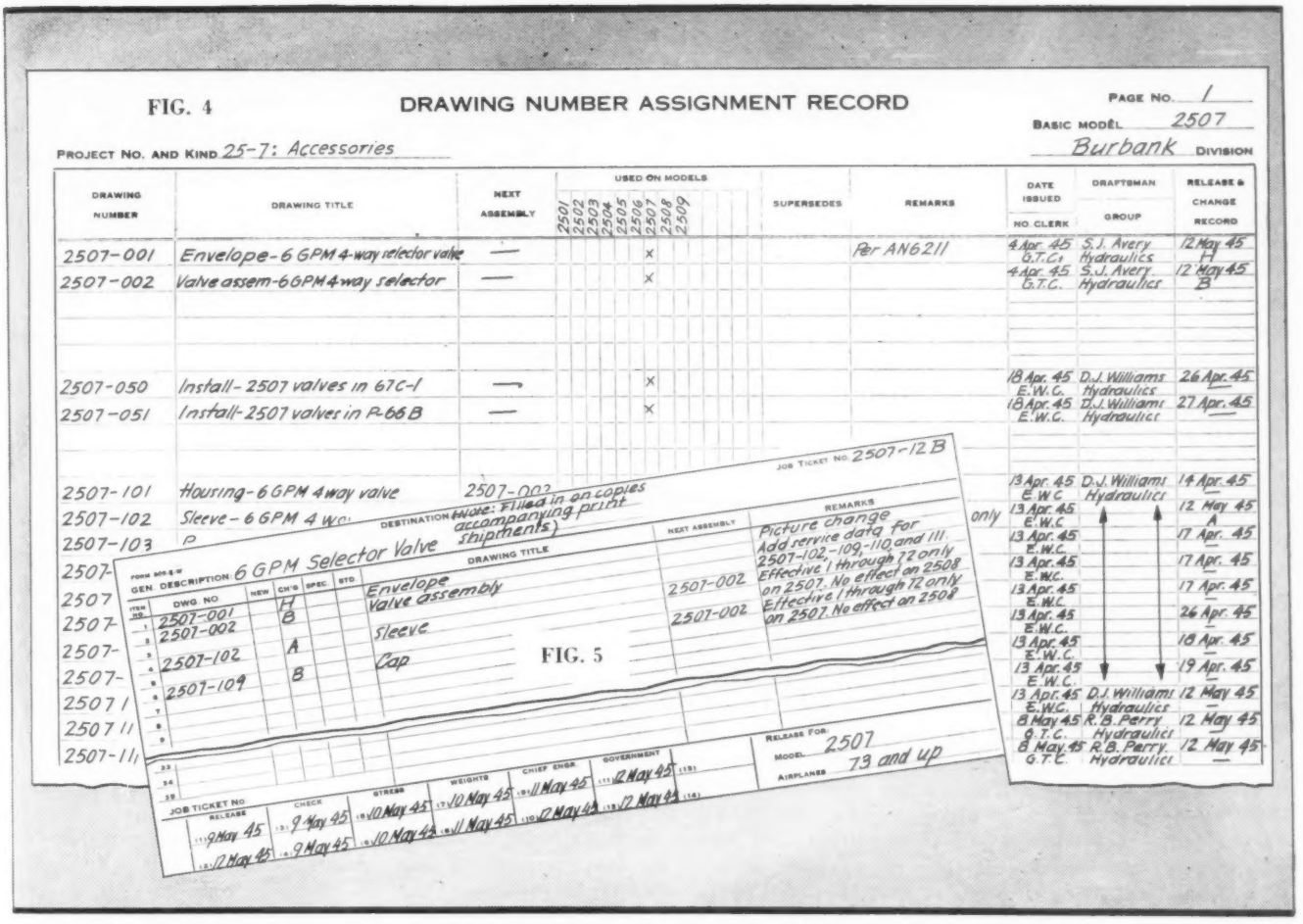


FIG. 4 DRAWING NUMBER ASSIGNMENT RECORD

PAGE NO. 1

BASIC MODEL 2507

PROJECT NO. AND KIND 25-7: Accessories

Burbank DIVISION

DRAWING NUMBER	DRAWING TITLE	NEXT ASSEMBLY	USED ON MODELS 2501 2502 2503 2504 2505 2506 2507 2508 2509	SUPERSEDES	REMARKS	DATE ISSUED / NO. CLERK	DRAFTSMAN / GROUP	RELEASE & CHANGE RECORD
2507-001	Envelope-6 GPM 4-way selector valve	—	×		Per AN6211	4 Apr. 45 G.T.C.	S.J. Avery Hydraulics	12 May 45 H
2507-002	Valve assem-6 GPM 4-way selector	—	×			4 Apr. 45 G.T.C.	S.J. Avery Hydraulics	12 May 45 B
2507-050	Install-2507 valves in 67C-1	—	×			18 Apr. 45 E.W.C.	D.J. Williams Hydraulics	26 Apr. 45 —
2507-051	Install-2507 valves in P-66B	—	×			18 Apr. 45 E.W.C.	D.J. Williams Hydraulics	27 Apr. 45 —
2507-101	Housing-6 GPM 4 way valve	2507-002				13 Apr. 45 E.W.C.	D.J. Williams Hydraulics	14 Apr. 45 —
2507-102	Sleeve-6 GPM 4 way					13 Apr. 45 E.W.C.		12 May 45 A
2507-103	P					13 Apr. 45 E.W.C.		17 Apr. 45 —
2507-						13 Apr. 45 E.W.C.		17 Apr. 45 —
2507						13 Apr. 45 E.W.C.		17 Apr. 45 —
2507-						13 Apr. 45 E.W.C.		26 Apr. 45 —
2507-						13 Apr. 45 E.W.C.		18 Apr. 45 —
2507-						13 Apr. 45 E.W.C.		19 Apr. 45 —
2507 I						13 Apr. 45 E.W.C.	D.J. Williams Hydraulics	12 May 45 —
2507 II						8 May 45 G.T.C.	R.B. Perry Hydraulics	12 May 45 —
2507-III						8 May 45 G.T.C.	R.B. Perry Hydraulics	12 May 45 —

FIG. 5

JOB TICKET NO. 2507-12B

GEN. DESCRIPTION 6 GPM Selector Valve

DESTINATION (Note: Filled in on copies accompanying print shipments)

ITEM NO.	DWG. NO.	NEW	CH'G	SPEC.	STD.	DRAWING TITLE	NEXT ASSEMBLY	REMARKS
1	2507-001		H			Envelope		Picture change
2	2507-002		B			Valve assembly	2507-002	Add service data for 2507-102, -109, -110 and 111 only Effective 1 through 72 only
3						Sleeve		
4	2507-102		A				2507-002	on 2507. No effect on 2508
5						Cap		Effective 1 through 72 only
6	2507-109		B					on 2507. No effect on 2508

RELEASE FOR MODEL 2507 AIRPLANES 73 and up

JOB TICKET NO. RELEASE (11) 9 May 45 (12) 12 May 45 | CHECK (13) 9 May 45 (14) 9 May 45 | STRESS (15) 10 May 45 (16) 10 May 45 | WEIGHTS (17) 10 May 45 (18) 11 May 45 | CHIEF ENGR (19) 11 May 45 (110) 12 May 45 | GOVERNMENT (111) 12 May 45 (112) 12 May 45

Fig. 4—Drawing numbers are posted in the master numbers book on the form shown.
Fig. 5—Drawing release request, used when a job is ready for release to manufacturing.

book, so that drawing number, title, next assembly and other data are the same as originally authorized by the numbers clerk. Discrepancies are investigated, and suitable corrections made in the record.

After the new drawing is completed, or the required changes have been made to an existing drawing, it is given by the draftsman to his group supervisor for checking and approval before it is placed on the release system. The group supervisor is responsible for the functional correctness of the design shown on a new drawing, and for the correct incorporation of all change data on a changed drawing.

Job Release Procedure

Individual drawings are rarely sent through the release system. Instead, groups of related drawings, known as "jobs," are processed and released as units. It is rare that an individual drawing is changed without affecting other drawings. The one changed drawing is of little value to the factory departments unless prints of other affected drawings are received simultaneously.

A single new drawing is of little value to the manufacturing department. An assembly without its details cannot be properly planned, nor can materials be ordered. On the other hand, a detail without its next assembly is of little value. The material can be ordered, but assembly planning and tooling cannot be established, and the manufacturing planning must remain partially completed until the assembly print is received.

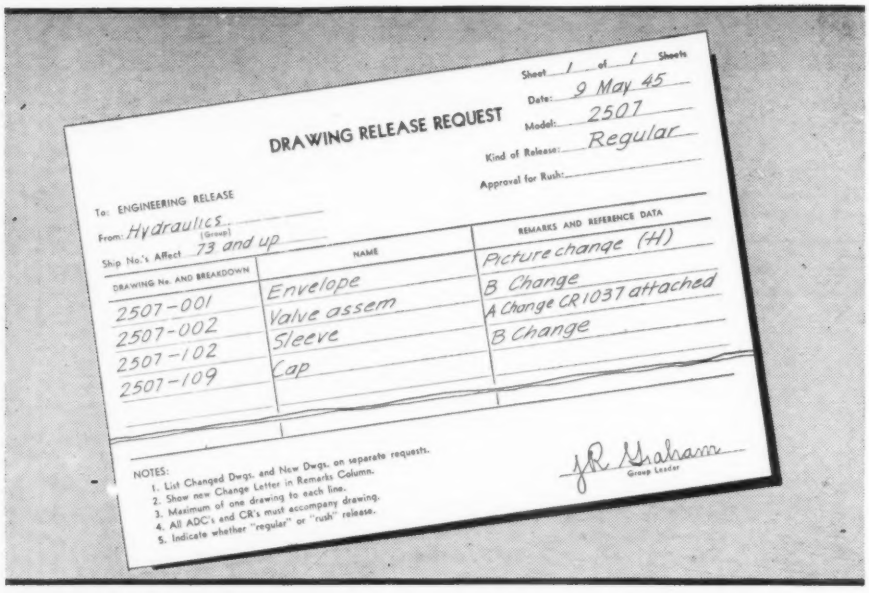
New drawings are ordinarily released in jobs comprising an assembly and its details. Changed drawings are released in jobs comprising all drawings affected by the change, together with any new drawings involved. If the change is of considerable magnitude, it is likely to be released as several jobs, each comprising a complete group of related drawings. In general it is good practice to maintain jobs at a maximum of 25 drawings.

When a job is ready for release the group supervisor prepares a Drawing Release Request, similar to that shown at Fig. 5, listing the drawings involved. Suitable explanatory remarks and a schedule of reference data forwarded with the job are also shown. This reference data usually comprises layout drawings and copies of all Engineering Orders, Advance Drawing Changes and Change Requests noted in the drawings.

Separate Release Requests are made for the new and changed drawings forming the job, but both requests and all drawings involved are forwarded to the Release group as a unit. This is particularly necessary when the routing of new and changed drawings is different, as shown at Fig. 2. Segregating the drawings at the source greatly simplifies the Release group's work. Engineering departments wherein the system routing is the same for all drawings will find it advantageous to list the entire job on one Release Request.

The Release Request provides the Release group with definite authorization to begin processing the job, and also provides a means of approving "rush" jobs. There will be occasions when it is important that one drawing or group of drawings be processed and prints released to the factory as soon as possible. These are handled as "rush" jobs, and given preference over all other jobs in the system. The approval of the chief draftsmen must appear on the request authorizing a rush job.

When the Release Request with re-



DRAWING RELEASE REQUEST

Sheet 1 of 1 Sheets
Date: 9 May 45
Model: 2507
Kind of Release: Regular
Approval for Rush:

To: ENGINEERING RELEASE
From: Hydraulics (Group)
Ship No.'s Affect 73 and up

DRAWING No. AND BREAKDOWN	NAME	REMARKS AND REFERENCE DATA
2507-001	Envelope	Picture change (H)
2507-002	Valve assem	B Change
2507-102	Sleeve	A Change CR1037 attached
2507-109	Cap	B Change

NOTES:
1. List Changed Dwgs. and New Dwgs. on separate requests.
2. Show new Change Letter in Remarks Column.
3. Maximum of one drawing to each line.
4. All ADC's and CR's must accompany drawing.
5. Indicate whether "regular" or "rush" release.

J R Graham
Group Leader

Fig. 6—Job ticket prepared in triplicate after job is received by Release group.

lated drawings and data is delivered to the Release Group, the actual processing of the job by the release "system" begins. The work of the Release group in handling jobs is divided into three prime functions of recording, dispatching, and print distribution. All three functions can be done by one person in a small engineering department, whereas a large department requires a chief release clerk with lead personnel in charge of each function.

Each new job delivered to Release is assigned a job number and checked against the Release Request or requests to ascertain that all listed drawings and reference data are attached.

When the system routing is different for new and changed drawings it is necessary to split jobs comprising both new and changed drawings into two parts. These are identified by "*A*" and "*B*" suffixes to the job number. The job number consists of the model designation for the article covered by the drawings, followed by a serial number. For instance, the specimen Job Ticket shown at Fig. 6 covers job 2507-12B. This indicates that it comprises the changed drawings forming a part of the twelfth job relating to model 2507.

After the job is checked a Job Ticket is prepared in triplicate, using a form shown at Fig. 6. The Job Ticket is an invoice of the drawings forming the job, a traveler to accompany the job through the system, a log of the location of the job in the system, a record of the job's checking and approval, and finally a notice to those receiving prints when the job is released.

The original of the Job Ticket accompanies the job through the system, and is signed by each person checking or approving the job. The duplicate copy is sent to the release recorder for use in posting the Drawing Status Cards, see Fig 7, and remains in the Release active-job file while the job is in the system. It is posted to show the dates the job is delivered to and received from each station in the system. The traveler strip at the lower margin of the Job Ticket is used for this purpose. The triplicate copy is forwarded to the engineering Planning group, as notification of the drawings entering the release system.

Drawing Status Record

Prior to actually placing the job in the system, the Drawing Status Record card for each drawing is posted. A specimen status record card, intended for use with a visible filing system, is shown in Fig. 7. This card is the master release record for each drawing, showing each release, together with all Advance Drawing Changes and Change Requests issued against the drawing. The drawing change incorporating each of these are included, together with a record of all Engineering Orders issued against the drawing. Stop Orders issued to halt manufacturing are also listed, together with a record of their release.

Advance Drawing Changes are documents issued to authorize drawing changes in advance of actual change. Their use expedites issuance of change information to the factory. Engineering Orders are similar documents which provide engineering authorization for items not requiring a drawing change. For instance, an *EO* should be used to issue special rework instructions for salvaging incorrectly manufactured parts.

Each Drawing Status Record card provides the following up-to-the-minute information, available to all interested parties, for one drawing: drawing number; drawing title; model that card relates to; other models used on; date of original release; date of all changes released; time in system on each release; job number of each release; *ADC*'s outstanding and incorporated; *EO*'s relating to the drawing; Change Requests outstanding and incorporated; and Stop Orders active and released.

It is the responsibility of each draftsman assigned drawing change work to contact Release and obtain the current status of the drawing before proceeding to work. The checking group contacts Release when the drawing is received for checking—to make certain that all outstanding *ADC*'s and change Requests have been incorporated. If an active Stop Order exists against the drawing, this must be released simultaneously with the drawing change—for a stopped drawing cannot be re-released.

Colored signal flags, affixed to the lower margin of each card, give visual indication of the drawing's status. These cards are placed on visible filing boards supported by stands. Thus, all concerned with each model may immediately obtain a "mass impression" of its progress from the colors displayed on the cards. In some cases it may be found advantageous to use alphabetical signals on the cards to show the latest change letter. The card shown at fig. 7 provides this feature.

The following signals are used on the Drawing Status Card visible files:

Letter—Indicates latest change letter.
Orange—Indicates drawing number issued.
Pink—New drawing in system (orange signal removed).
Green—Drawing released. Remains until drawing cancelled. (pink signal removed).
Yellow—Drawing in system on change. (removed when change released).
Red—Active Stop Order (removed when Stop is released).
Blue—Unincorporated Advance Drawing Change or Change Request. (removed when all incorporated)
Brown—Drawing void or cancelled.

A complete set of Drawing Status Record cards is maintained for each model. When a drawing is used on more than one model there is a Status card for the drawing in each model file. The space on the card marked "Basic Model" and "Other Models Released For" records the cards existing for each drawing. The "Basic Model" space always shows the model that the file relates to, while the "Other Models Released For" shows the other model files in which cards for the same drawing will be found. When a drawing change is released it is necessary to post appropriate information on all Status

cards existing for the drawing. The same action is taken when an Advance Drawing Change, Engineering Order or Change Request is issued. The issuance and release of a Stop Order is shown only on the card for the model affected.

This duplication of Status cards may seem unnecessary at first glance, but investigation will reveal that it is necessary to have a complete release record for each model—for the release procedure is for the purpose of controlling the release of data required by the factory to construct a certain model. It will also become apparent that certain drawing changes, Advance Drawing Changes, Stop Orders, and the like, may have different effects upon the various models covered by the drawing—so again a complete Status file for each model is imperative. For instance, a Stop Order may be issued to halt manufacture of a part for one model only, without affecting its use on several other models.

Should it be found undesirable to use a visible file for the Drawing Status Record cards it is possible to rearrange the identical card for use in a box file. It is only necessary to move the record strip from the bottom of the card to the upper margin, and place the signals along the top of each card.

Handling of Jobs

Jobs placed in the system cannot be expected to carry on under their own momentum. Instead, the Release dispatcher has the responsibility of delivering each job to the next station in the System, picking up all completed and approved jobs and personally forwarding these to the next station. Boxes at each station for incoming and outgoing jobs provide specific places for the dispatcher's deliveries and pickups. The dispatcher also has the responsibility of expediting jobs which appear to lag, through urging speedier action by the station at fault.

The dispatcher records the location of each job, using the traveler strip along the lower margin of the duplicate Job Ticket in the active-job file. The original copy of the Job Ticket is signed and dated in the same spaces by the person in charge of each station, upon the job being completed and ready for the dispatcher.

Release prepares a daily report showing the location of each job in the system, together with notation of jobs which appear unduly delayed. Copies are forwarded to Engineering Planning, the Chief Clerk and the Chief Draftsman. The necessary corrective action is taken by the Chief Draftsman or Chief Clerk, depending upon the station at fault. Planning is thus constantly advised of each drawing's progress, and assists in cases where delay is caused by lack of personnel at a particular station.

Releasing the Job

Upon receiving the customer's approval a job has completed the system and is ready for release. At this time the *A* and *B* portions of a job split because of containing both new and changed drawings are collected to form one job. Occasionally the complete, approved job must be routed to the Parts List Group prior to actual release. This is desirable when a Master Parts List is maintained for each model or article, and copies are distributed throughout the factory. In such cases the Master Parts List is the only authentic record of active drawings, and should be revised and reissued concurrently with the daily release of jobs.

Every station added to the release system increases the time required to process a job, and it may be advantageous to eliminate the Parts List Group from the system. If so, prints of each job can be forwarded directly to the Parts List Group by Release, as authority to make appropriate corrections to the Master Parts List.

When the completed job is received the release clerk checks to ascertain that it contains all drawings shown on the Job Ticket, and then prepares instructions regarding the quantity and kind of prints required. The information is entered in the space provided at the upper margin of the Job Ticket. The job is then forwarded to the Blue-

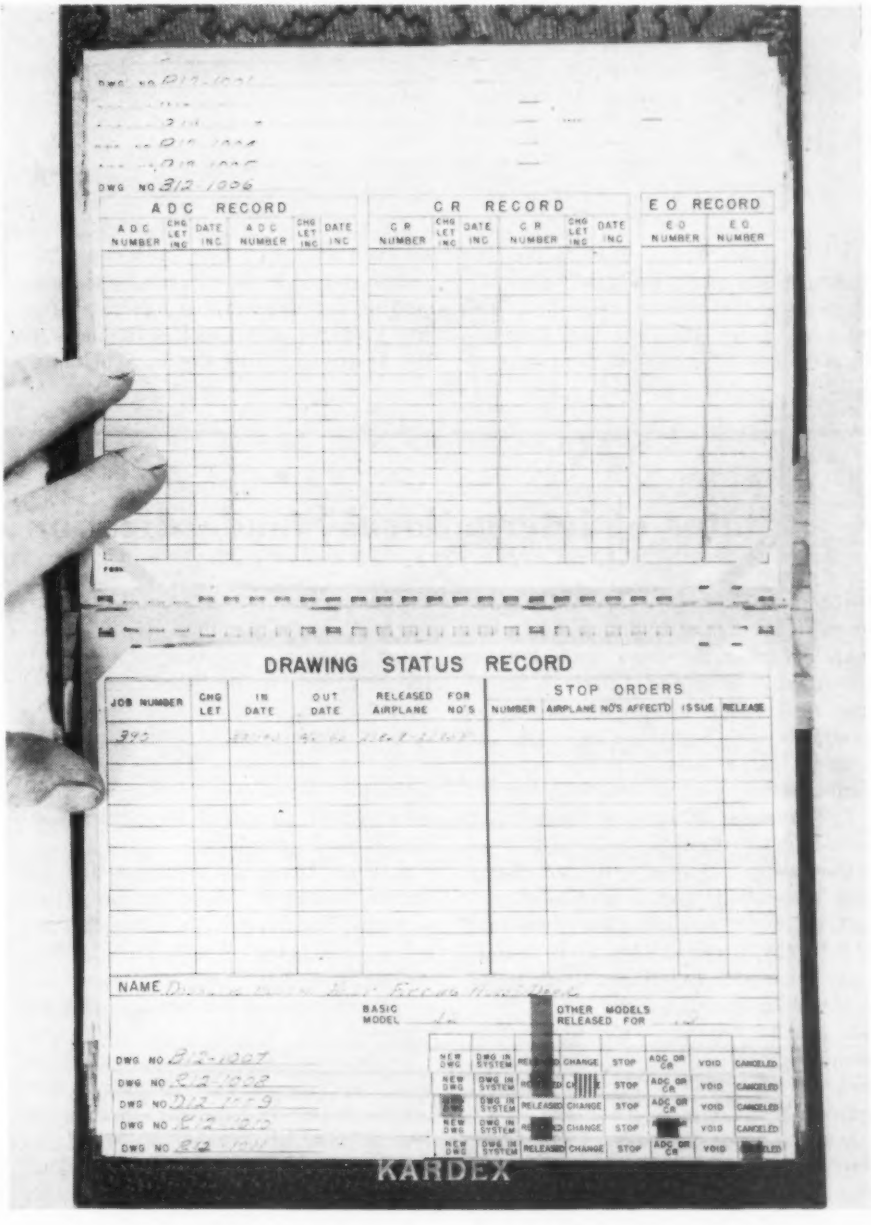


Fig. 7—Drawing status is recorded on a visible indexing card. Colored signals placed over appropriate squares indicate drawing status.

print Group for preparation of the necessary prints. Prior to sending the job to Blueprint, the release clerk removes all reference data and returns these to the proper files.

The Blueprint group stamps the printing date on each tracing, opposite the appropriate change letter in the alteration-block, and makes the required prints. Placing the printing date on the tracing eliminates entering the date on each print. The drawings, Job Ticket and prints are then returned to Release.

The release clerk checks the job in, returns drawings to the engineering file, and forwards prints to the print-clerk. Each print is marked with issue-number and destination to provide positive individual identity, and the print issue-record cards are posted. The prints are then gathered in bundles for each destination. A shipping notice is prepared in duplicate for each bundle, and the original copy of the shipping notice is delivered with the prints. The duplicate is signed by the recipient and retained by Release as proof of delivery.

Completion of Job

When prints are delivered, the Job Ticket is stamped "Released" and forwarded to the release recorder. The recorder posts the affected Drawing Status Cards to show that the job is released. The duplicate Job Ticket is removed from the active-job file and destroyed, and the original Job Ticket placed in the closed-job file.

In some cases a copy of the Job Ticket is forwarded to each destination with the prints forming the job. This is good practice and provides information on the general nature of the job and its relationship to the model or article affected. Choice of this method is governed by comparing the value of this information with the cost of preparing additional copies of the Job Ticket. These additional copies are prepared just prior to release of the job, to avoid errors caused by possible changes in the nature of the job which might have occurred during its course through the system.

The prints intended for the engineering files are routed to the numbers-clerk prior to delivery to the files. This permits the numbers-clerk to check the prints against the numbers books, and makes appropriate corrections or entries in the books.

One print of each drawing release is designated as a "vault copy," and is intended for a master file, in which is maintained one print of every change on each drawing. This vault-copy print is first routed to the release-recorder for posting the incorporated Advance Drawing Changes and Change Requests on the Drawing Status Cards. This information appears on the Notice of Change attached to each changed drawing.

Certain articles or models may be classified as "confidential" or "secret," and special treatment is required for major assembly drawings revealing the nature and purpose of the design. Detail parts and sub-assemblies rarely reveal any significant data, and may usually be handled in the same manner as unclassified drawings.

It is the responsibility of the Project Engineer to determine which drawings are to be classified as confidential or secret. These drawings are plainly marked with the appropriate security classification, and prints are not issued as part of a regular job release, except that a "vault-copy" print is made. The Release group, instead, notifies all normal recipients of prints when a classified drawing clears the system, and parties requiring prints may request "special issue" prints. The issuance of prints of classified drawings requires specific approval of an engineering executive.

The next article in this series, to appear in a forthcoming issue, will begin a discussion of Drawing and Print Control. Previous articles covered Organization (March); Personnel and Cost Control (May); Engineering Planning (June).

Status of International Standardization of Screw Threads

SINCE THE LONDON CONFERENCE on Screw Threads and Cylindrical Fits last year, progress has been made by the war committees of the American Standards Association toward agreement on standards by British, Canadian and United States industry. The present status of this work is reviewed briefly:

1. Truncated Whitworth Threads. An amendment to British standard BS84—1940, received from the British Standards Institution, and a proposed revision of the American War Standard B1.6—1944, prepared by A. E. Smith, Army Ordnance Department, are being reviewed for coordination.

2. Acme Threads. American War Standard B1.5—1945 is being considered for adoption by British industry, and has been adopted in Canada.

3. Stub Acme Threads. Data for a proposed standard is being prepared.

4. Cylindrical Fits. British and American proposals were incorporated into a draft of a proposed standard. Because of certain objections on the part of representatives of the automobile industry on ASA War Committee B4, it was decided to use the standard as a guide to industry, to be published for a trial period of two years.

5. High-Duty Studs in Light Alloys. ASA War Committee B1 has agreed on principles to be used as the basis of a standard, which will be forwarded to the British and Canadians.

6. Pipe Threads. American and Canadian standards, based on the British standard for pipe 4 in. diameter and below, are being considered. A draft specification has been prepared and circulated to tool and fitting manufacturers.

7. Buttress Threads. No proposal has been received from the British as yet. Technical material can be found in the new edition of Bureau of Standards Bulletin H28, "Screw Threads for Federal Services."

8. Instrument Screw Threads. Work is under way by the British on a draft specification for fastening screws smaller than 0.06 in. diameter.

9. Screw Thread Unification. The research program to furnish data on which a proposed British-American-Canadian screw thread system can be built is to be carried on by the National Physical Laboratory in England, the National Bureau of Standards, Washington, and the Department of Mines in Canada.

10. Nomenclature. The Bureau of Standards is preparing a compilation of American practice regarding symbols. When completed, it will be sent, together with a proposed unified system, to the British for consideration.

11. Drawing and Drafting Practice. An ASA committee will study proposals made by C. A. Gladman of the Department of Scientific and Industrial Research of Great Britain in his paper on Drafting Room Practice in Relation to Interchangeable Components, presented before the Society of Automotive Engineers. Mr. Gladman's paper was abstracted in the March, 1945 issue of PRODUCT ENGINEERING.

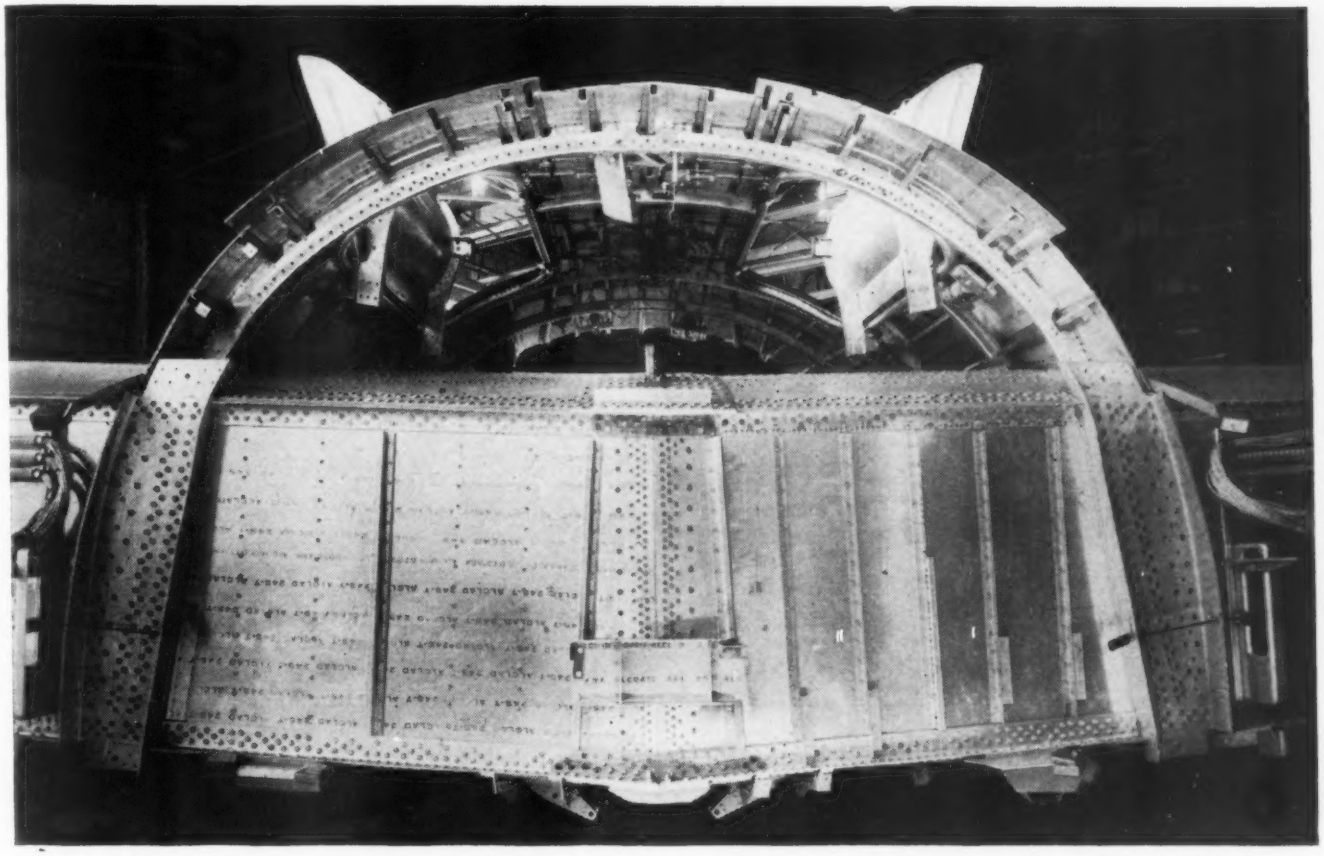


Fig. 1—Wing-to-fuselage splice fittings of a Liberator B-24 as seen looking toward the rear spar.

Elongation in Aircraft Spars Caused by Riveting Operations

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Effects of drilling, rivet expansion and pressure of heading on the misalignment of holes and the elongation in long aircraft spars for different ratios of rivet length to diameter and different thicknesses of material. When material thickness is small in comparison with rivet diameter, tests show that the elongation is not related to material thickness.

THIS discussion deals with the procedure and results of an investigation to determine the amount of elongation in aircraft section spars caused by riveting and whether this elongation causes misalignment of holes.

In fabricating, the spar webs are drilled and burred; stiffeners are cut, drilled and riveted to the webs. Webs and cap strips are then placed in an assembly fixture, where about 10 percent of the rivet holes are transferred from the webs to the cap strips. The holes as drilled in the webs are 5/32 in. and are transferred to the cap strips by an "A" (0.234 in.) drill.

The cap strips and webs are then removed from the fixture and the burrs removed. The cap strips and webs are again assembled in the same fixture and approximately 10 percent of the ¼ in. rivet holes are redrilled to "F" (0.257 in.). Before removal from the fixture, ¼ in. type D rivets are squeezer driven in the redrilled holes.

After removal from the fixture, web splice plates are added to the spar, then the remaining 90 percent of the "F" (0.257 in.) holes to be drilled are drilled by a high-speed radial drill or by a small radial using a stack drill. Then ¼ in. 17ST-A rivets are squeezer driven in these holes.

The only burring necessary is that done at the time the first holes are transferred from the webs to the cap strips. There are approximately 1,400 rivets in each spar, approximately 1,100 of which are ¼ inch.

After all riveting operations are completed, the spars are inspected for defective rivets. Approximately 1½ per-

Table I—Elongation in Specimen Strips After Riveting

Material Thickness, In.	Elongation of Specimens, in. No. 1	No. 2	No.3	No. 4	No. 5	Average
0.032	0.024	0.020	0.026	0.037	0.028	0.027
0.040	0.003*	0.033	0.026	0.022	0.033	0.028
0.051	0.038	0.022	0.036	0.031	0.017	0.028
0.064	0.026	0.037	0.038	0.030	0.031	0.032

Table II—Elongation in Specimen Strips After Squeezing

Material Thickness, In.	Elongation of Specimens, in. No. 1	No. 2	No.3	No. 4	No. 5	Average
0.032	0.004	0.008	0.004	0.004	0.004	0.005
0.040	0.003	0.008	0.001*	0.003	0.005	0.005
0.051	0.000*	0.000*	0.000*	0.003	0.004	0.003
0.064	0.001*	0.007	0.010	0.004	0.011	0.009

Table III—Elongation in Thick Specimen Strips

Material Thickness, In.	Elongation of Specimens, in. No. 1	No. 2	No. 3	No. 4	No. 5	Average
1/8	0.020	0.024	0.025	0.012	0.006*	0.020
3/16	0.012	0.015	0.020	0.022	0.009	0.016
1/4	0.012	0.015	0.012	0.012	0.012	0.013

*This value is not included in the average.

cent, 20 to 25, of the rivets are found to be defective, these are replaced. Most of the defective rivets are caused by improper squeezing, less than 10 percent have cracked heads.

After inspection and replacement of all defective rivets, the spars are moved to a set of vertical jig fixtures where they are assembled, one right-hand and one left hand, to form a pair. In these fixtures, the spars are trimmed to correct length, outer panel attaching forgings are riveted in position, and the splice plates between right-hand and left-hand spars are fitted and drilled. Fittings and angles which require accurate locating with respect to the center line are jig drilled and riveted in place. The attaching fittings at outer ends of the spars are then milled. The spars are then ready for final assembly, and are the correct over-all length regardless of expansion that could be attributed to riveting or other causes.

To determine the amount of elongation caused by riveting, before any 1/4 in. rivets were driven, marks were placed about 27 ft. apart on the cap strip flanges near the ends. The distance between the marks was carefully measured with a steel tape. Ten spars measured after riveting prior to being placed in the vertical jig fixtures, were found to have elongated, the amount ranging from 0.050 to 0.060 inches.

Five more spars were marked and measured before any 1/4 in. rivets were driven. After riveting, these spars were measured again after the center section was removed from the final assembly fixture and were found to have elongated distances of 0.060 to 0.100 inches.

These measurements were made with the same steel tape by the same persons, yet in each case the measurements should not be taken as exact values, but rather that the readings indicate an appreciable elongation, approximately 0.100 in., takes place in each left-hand and right-hand spar cap strip from the time riveting is started until the center section is complete.

It should be noted that approximately 10 percent of the 1/4 in. rivets are distributed along the entire length of the cap strips before the remainder is set. Therefore, misalignment of holes does not take place because of elongation. Also, misalignment within the short distances, about 6 in., between the tack rivets is small and negligible for practical purposes. The total elongation is therefore probably the sum of the elongations of all the small sections between the tack rivets.

Obviously the elongation results from stretching the material beyond its yield point or by stretching to some value less than the yield point and there maintaining a reactionary force sufficient to prevent at least a portion of its return to the original dimension.

To determine whether the stretching is caused principally by the compression of relatively small areas under the rivet heads or by the force exerted by the expansion of the rivet material in the rivet hole, the following experiments were conducted.

Holes were drilled for forty-six 5/16 in. type AD rivets at 1/2 in. centers on the center lines of 24S-T Alclad strips 1 in. wide by 26 in. long. The thicknesses of the strips were 0.032, 0.040, 0.051 and 0.064 in. After drilling the holes, the lengths of the strips were accurately measured. Then rivets were inserted in the holes and squeezed. After squeezing the rivets, the lengths of the strips again were measured carefully, and the over-all elongations of the strips were calculated. Table I gives the over-all elongation of the different specimens.

Strips of the same materials and the same dimensions, but without holes, were squeezed by the same rivet squeezer using the same pressures in the same number of places. From measurements taken before and after squeezing, the elongations given in Table II were calculated.

The results of these experiments in-

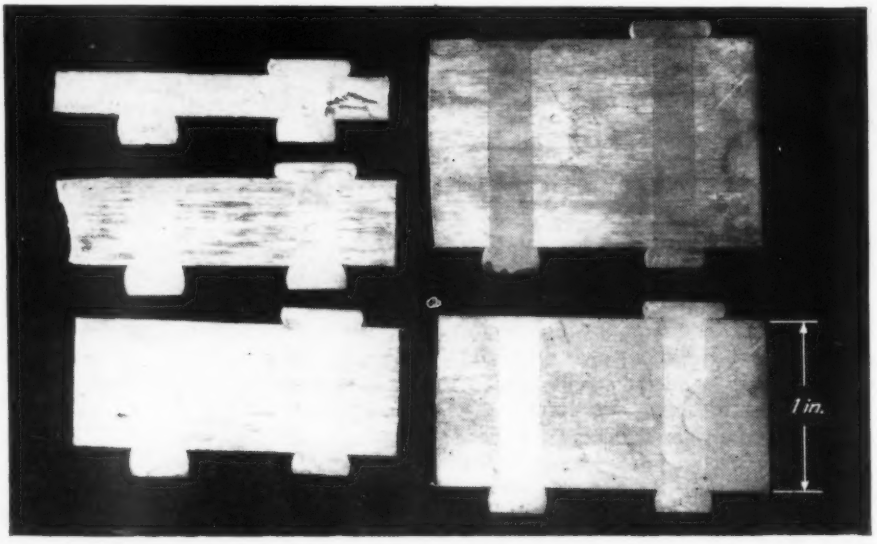

Fig. 2—Sections cut through 1/4 in. 17S-TA flat head and type D countersunk head rivets set alternately, in five different thicknesses of Alclad strip.

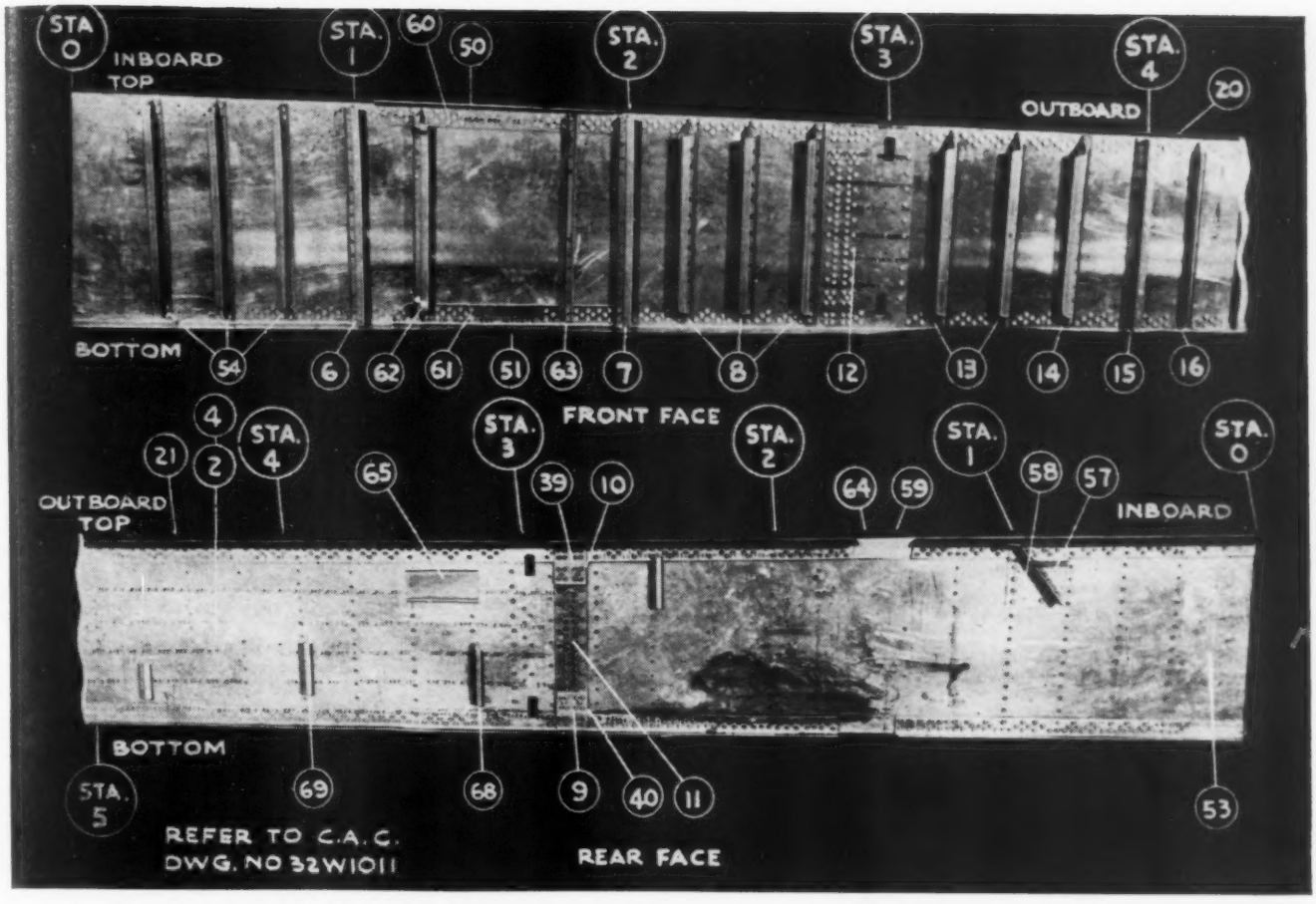

Fig. 3—Inboard section of the rear spar of a Liberator B-24 wing center panel.

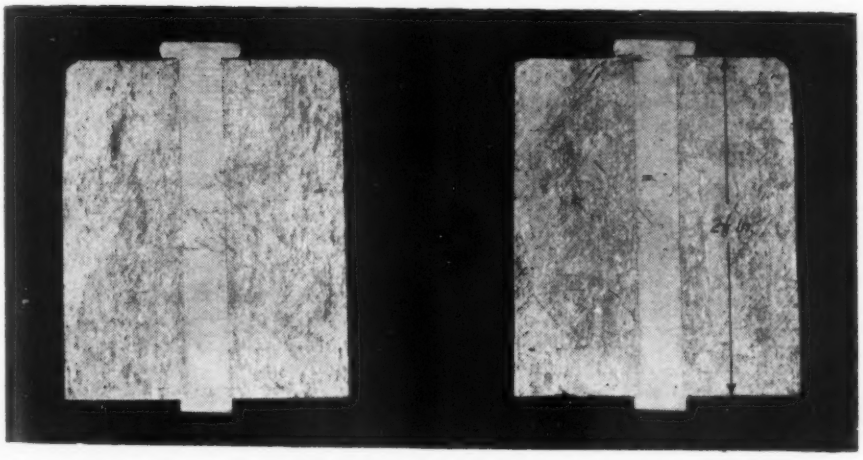

Fig. 4—Sections cut through ¼ in. 17S-TA rivets set in 2 in. thick Alclad strips.

dicate that approximately 80 percent of the elongation is caused by the rivet expanding in the hole, and that the elongation is approximately 0.0006 in. per $\frac{3}{16}$ in. type AD rivet in strips 1 in. wide.

Note that the elongation is approximately the same for all thicknesses of material. This coincidence probably occurs because as the rivet shanks expand the force per unit of bearing area which causes elongation in an 0.032 in. strip is the same as that in an 0.064 in. strip for a rivet of given diameter.

To confirm this deduction, five pairs of 0.032 and 0.125 in. thick strips, 1 in. wide by 26 in. long were drilled together. In each pair of strips 46 rivets were set starting at one end and progressing to the other without setting tack rivets. No misalignment of holes could be observed as a result of the difference in elongation between the 0.032 and the 0.125 in. thick materials. This observation does not imply that the practice of setting tack rivets is not necessary.

As a further test, strips 1 in. wide by 26 in. long having thicknesses of $\frac{1}{8}$, $\frac{3}{16}$ and ¼ in., were drilled for forty-six $\frac{3}{16}$ in. type D rivets spaced on ½ in. centers on the center line of the strips, and rivets set with a squeezer. Measurements taken before and after rivet squeezing showed over-all elongations as given in Table III. The results of this experiment, in which the ratio of the length to the diameter of rivet was of three different values, also show that the elongation is approximately the same for all thicknesses of the same material for rivets of a given size.

To determine whether 17S-TA rivets expand and fill the rivet holes through the entire shank length, twenty ¼ in. type D countersunk head rivets were set alternately 1 in. apart in strips ¼, ½, ¾, 1, and 1¼ in. in thickness, that were drilled with an "F" drill, 0.257 in. These strips were then sectioned through the rivets. All the rivets completely filled the holes through the entire shank length. Fig. 2 shows sections of each of the strips, each section is representative of those in the entire length of the respective strips.

In addition, twenty ¼ in. 17S-TA rivets were set in strips 2 in. thick. Sections cut through the rivets showed that all the rivets expanded through their entire shank length. The sections shown in Fig. 3 are representative.

In view of these results, it is evident that 17S-TA rivets expand the entire length of the shank for lengths equal to eight times the rivet diameter or less.

MECHANICAL PACKING DESIGN—

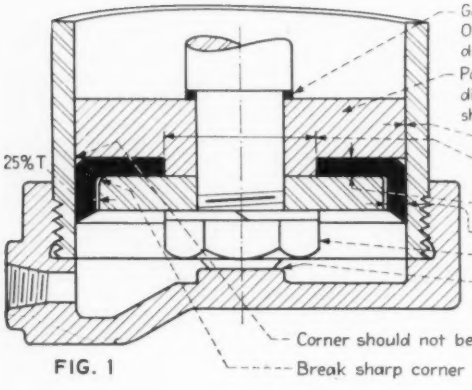
Gasket preferred for perfect seal. Other methods make disassembly difficult
Packing support plate must not distort. Follower plate or rigid cup-shaped casting or stamping can be used
Close sliding fit
25%T
Hub prevents excessive compression of packing
Hub thickness 80 to 85% T
T = thickness of packing
Locking means
Stop block prevents lip of cup from hitting bottom
Corner should not be rounded
Break sharp corner

FIG. 1

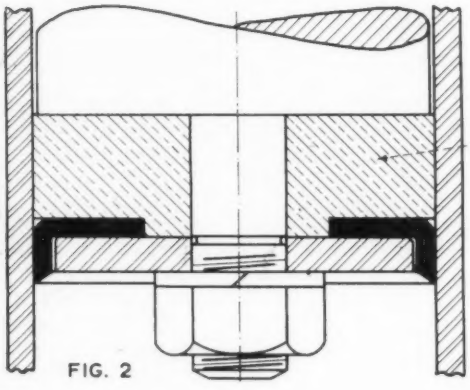
Separate backing plate on end of ram allows greater clearance between ram and cylinder, avoids fine finish on ram, and gives choice of material for bearing qualities

FIG. 2

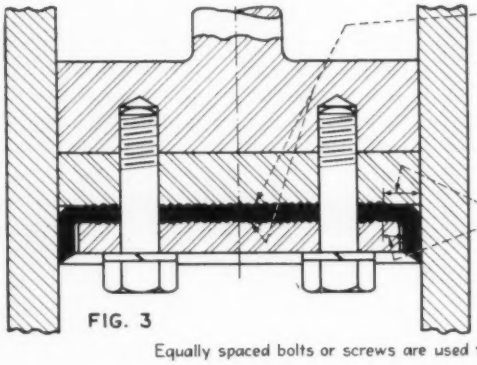
Fluting gives firm grip and better seal. It is particularly desirable when no hub is used
1/4 to 1/2 in. flat area at outside edges of packing

FIG. 3

Equally spaced bolts or screws are used for cups 4 in. or more in diameter

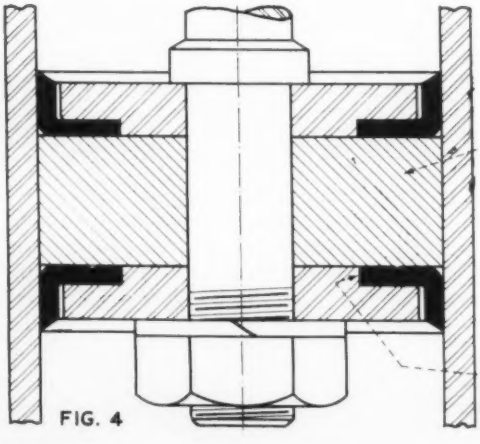
Substantial backing plate should always be used between two cups in double acting cylinder
Hub can be put on follower plate as well as on backing plate

FIG. 4

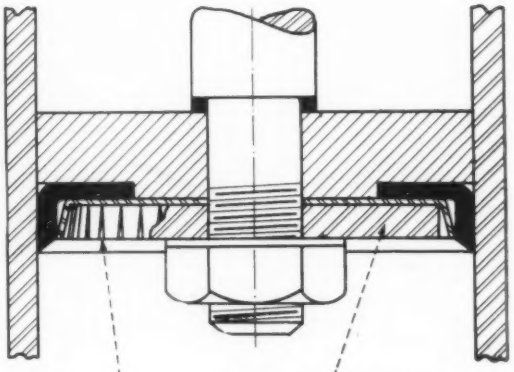
Follower plate diameter reduced slightly to allow for expander
Finger type expander. Design varies with equipment, size, pressures and materials

FIG. 5

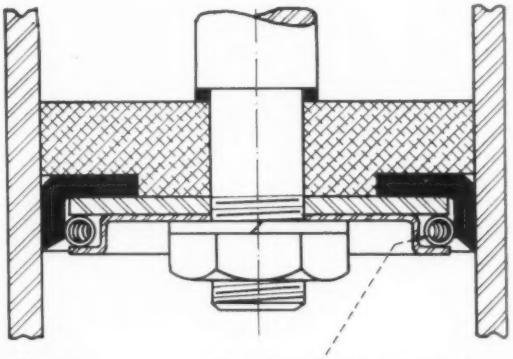

FIG. 6

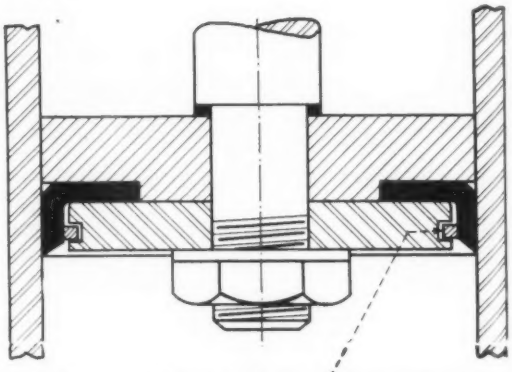

FIG 7

Use of expanders is always good practice but not always essential. They are required when cups are light and flexible, when sudden pressure differentials occur, and when part of stroke is manual and cup must suck in fluid to keep cylinder full. They are advantageous when cylinder is slightly out of round or tapers slightly, and when long standby periods are required.

CUP AND FLANGE TYPES

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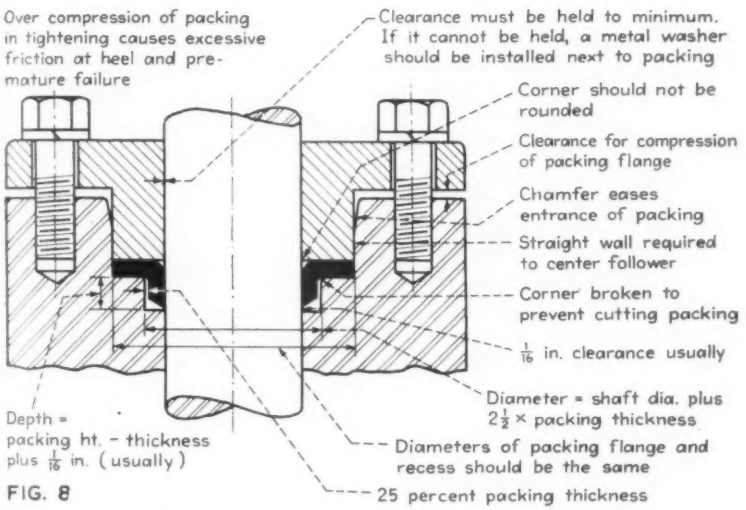
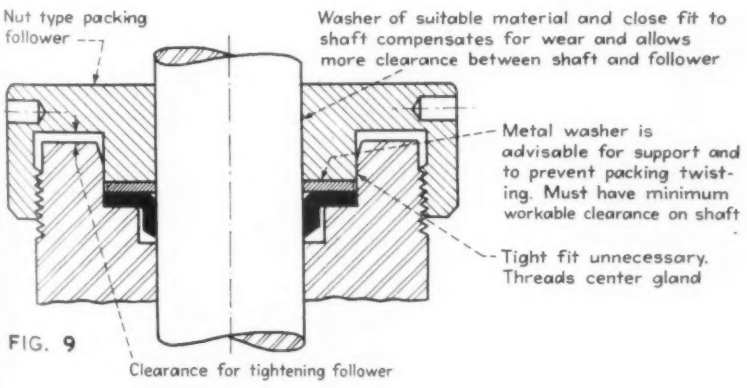
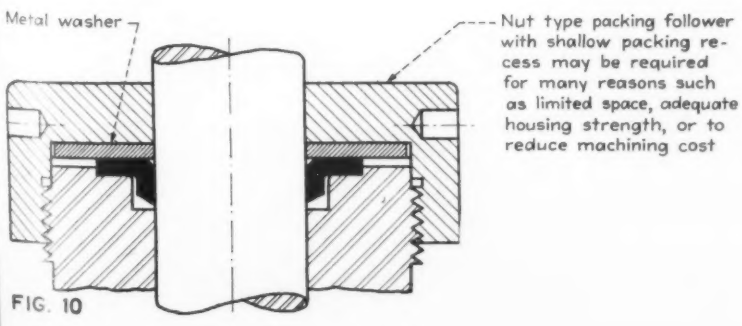
DESIGN FEATURES and certain basic rules for designing cup and flange packings and component parts, which are presented here, are based on data in a new "Mechanical Packings Manual," soon to be published by Graton & Knight Company. The cup, commonest type of mechanical packing, is used only on pistons, plungers, or rams in hydraulic or pneumatic service. Flange packings are used only in packing recesses, both for reciprocating plungers and as seals on rotating shafts. Two other types of mechanical packings, U-rings, and V-rings, for higher pressures, will be illustrated in September. Cup and flange packings are low in initial cost, simple in design and require a minimum of space.


Over compression of packing in tightening causes excessive friction at heel and premature failure
Clearance must be held to minimum. If it cannot be held, a metal washer should be installed next to packing
Corner should not be rounded
Clearance for compression of packing flange
Chamfer eases entrance of packing
Straight wall required to center follower
Corner broken to prevent cutting packing
1/16 in. clearance usually
Diameter = shaft dia. plus 2 1/2 × packing thickness
Diameters of packing flange and recess should be the same
25 percent packing thickness
Depth = packing ht. − thickness plus 1/16 in. (usually)
FIG. 8


Nut type packing follower
Washer of suitable material and close fit to shaft compensates for wear and allows more clearance between shaft and follower
Metal washer is advisable for support and to prevent packing twisting. Must have minimum workable clearance on shaft
Tight fit unnecessary. Threads center gland
Clearance for tightening follower
FIG. 9


Metal washer
Nut type packing follower with shallow packing recess may be required for many reasons such as limited space, adequate housing strength, or to reduce machining cost
FIG. 10

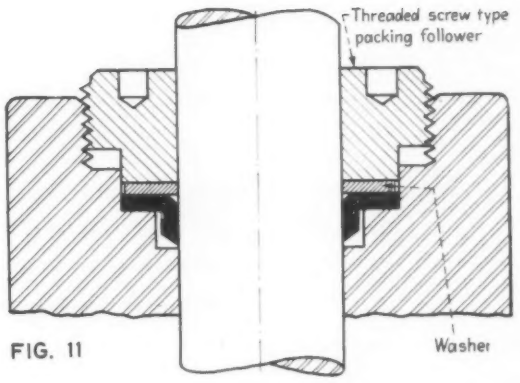


FIG. 11

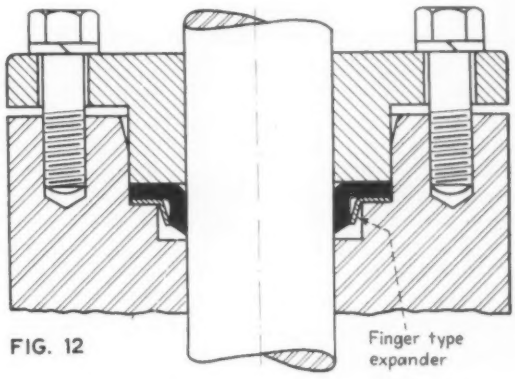


FIG. 12

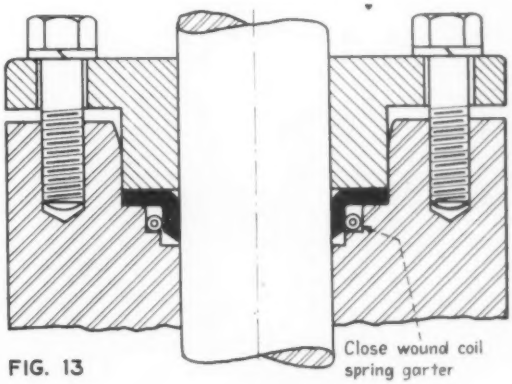


FIG. 13

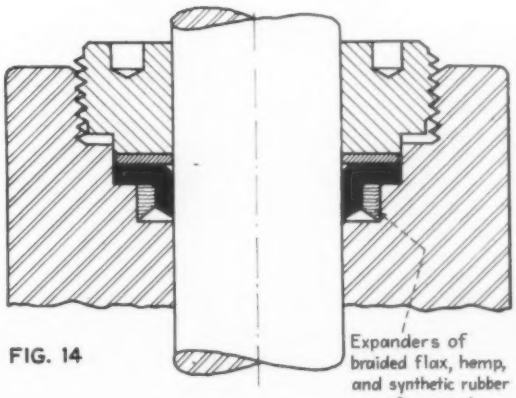


FIG. 14

Expanders are advised when cost permits

Design of Machine Tools For Safety and Production

A. WILLIAM MEYER

Assistant Director of Design, Brown & Sharpe Manufacturing Company

Features that should receive careful consideration in the design of machine tools to provide safety for operators and maintenance men, to prevent overloads caused by improper handling, to reduce manual effort required to manipulate controls, to insure uninterrupted production and to increase the efficiency of operators.

DESIGN features that promote the welfare and comfort of personnel and that insure uninterrupted production are of growing importance to users of machine tools. Therefore, two cardinal principles of good design are: Machines should be safe for the operators and the maintenance men; and machines should be provided with safety devices that prevent extensive and costly breakdowns caused by inept handling.

Although a designer can do much to safeguard the operator and the machine, some safety measures must be left to the operator's discretion. Physical injuries which result from carelessness, from disregard of obvious precautions, or from "taking chances" often cannot be avoided through any foresight of the designer.

Even when safeguards are provided for the broad and general conditions which surround the operation of production machines, there still remain incidental hazards dependent upon fixture design and tool set-up. These differ to such an extent from one job to another that the exercise of good judgment by the mechanic is indispensable in the prevention of accidents.

In the design of machine tools there are several features which should be given careful consideration. Moving tables, slides and other units should be guarded so that an operator will not be injured if he should lean against them or rest his hands upon them.

Stop controls should be placed in prominent positions for quick operation. Levers and control handles should be marked plainly with brief and precise data setting forth the results of movement in various directions. Movements of levers should be in directions corresponding to the path of movement which a slide or table is to take. Controls should be placed in readily accessible positions to reduce operator fatigue.

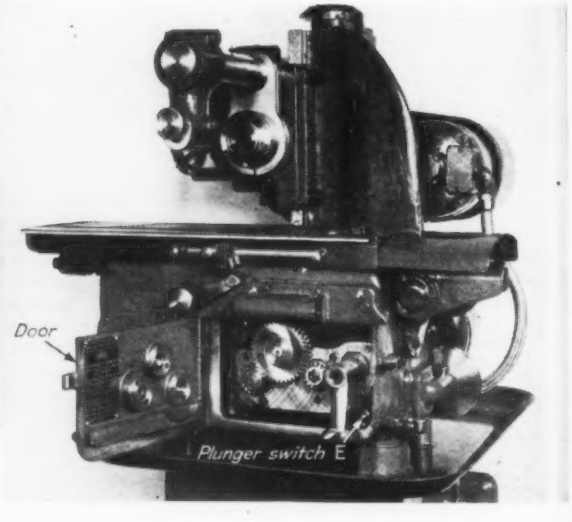
To eliminate physical exertion in the operation of machines, electrical or hydraulic features or a combination of both, and mechanical arrangements can often be incorporated in the machines.

Machines should be designed to facilitate cleaning. They should be "styled." have a pleasing appearance, so that operators will take pride in running them.

Some examples of recent improve-

Fig. 1—Guard on arm brace of milling machine covers moving table dogs and eliminates shear point at edge of brace.

Fig. 2 (Below)—Opening the pick-off gear door disconnects the power line to table feed motor, thus preventing gears from rotating when the door is open.



ments in the design of machine tools bear evidence of the constant striving by designers to save operating time, to reduce the manual effort required in the manipulation of machine controls, to eliminate hand work, and to promote safe operation and maintenance.

A safety table-dog guard is provided on the arm brace of the milling machine shown in Fig. 1. If no guard were provided and the arm brace were in use a dangerous shear point would be present between the moving dogs and the front vertical edge of the brace. To prevent injury to the operator, a sheet metal guard attached to the arm brace covers the dogs when the brace is upright, so that whenever the brace is in use the guard is in place and protects the operator.

In operation, the table of the milling machine, shown in Fig. 1, advances rapidly to the cutting point and then its travel is automatically changed to feed rate. At the end of the cut, the table is returned quickly to the loading position. The operation of a push button control proved to be tiresome on the operator's thumb and fingers, especially on short operations of 5 or 6 seconds duration which required 10 to 12 blows per minute on the small start button. To overcome this source of discomfort, a treadle-operated switch was provided to control starting.

With the treadle switch the workman has both hands free for loading and unloading the fixture, thus increasing his output per hour. To add further to his comfort and reduction of fatigue, the switch box was cable connected to permit operation from a seated position.

The same type of machine has also been provided with a lever controlled start push-button type switch. The lever is pivoted so that a light outward pull or pressure of the hand or forearm will start the operating cycle. Accidental leaning against the ball end of lever will not start the machine since an outward movement of the ball is required to depress the push button. The lever has eliminated broken finger nails, particularly those of women operators.

A design that protects the operator's fingers from injury, which could be caused by pick-off gears and table hand cranks, is shown in Fig. 2, where hand crank is mounted for manual table adjustment. To mount the crank or to change gears the door must be opened. Opening the door permits movement of a spring biased plunger switch *E* which disconnects the power line to the table feed motor, thus preventing gears from rotating while the door is open. Handle must be removed before door can be closed to depress plunger switch for reconnecting power line.

To avoid the use of wrenches and ensuing "skinned" knuckles, nuts are not used to hold the gears on their shafts. Circular end bearings integral with the door hold the gears on their shafts when door is closed.

On large machines which have both speed change and feed change gears, an electrical interlock is provided to stop both speed and feed motors whenever either cover door is opened.

An interesting example of design for the protection of mechanical parts is shown in Fig. 3. The spindle of this machine can be driven either at a low speed series with stepped pulley on lower shaft *F*, or at a high speed series with the same pulley mounted directly on machine spindle as shown. To prevent rotation of the reduction gear shaft at excessive speeds, as high as 17,000 r.p.m., a mechanical interlock necessitates locking the gearing positively out of engagement before the pulley can be mounted on the spindle. The interlock consists of an arrangement whereby pushing the knob at the end of the shaft beneath the spindle disengages the back gear, which permits moving the safety catch lever *G* away from the spindle, as shown in Fig. 3, and thus remove interference with mounting of pulley on the spindle.

A small and compact post unit for control of a milling machine table is shown in Fig. 4. This push button controls full manual manipulation of the machine, and by use of dogs provides automatic cycles of operation in a selected sequence of movements. This design reduces operator fatigue, eliminates the hazard of human error and assures the maintenance of a predetermined timed cycle of automatic operation.

The four small push buttons control the rate and direction of table travel.

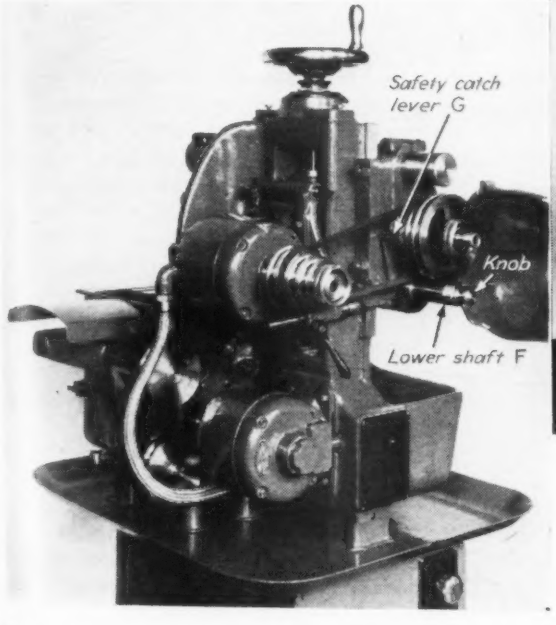


Fig. 3 (Below)—Mechanical interlock necessitates locking the gear positively out of engagement before pulley can be mounted on the spindle.

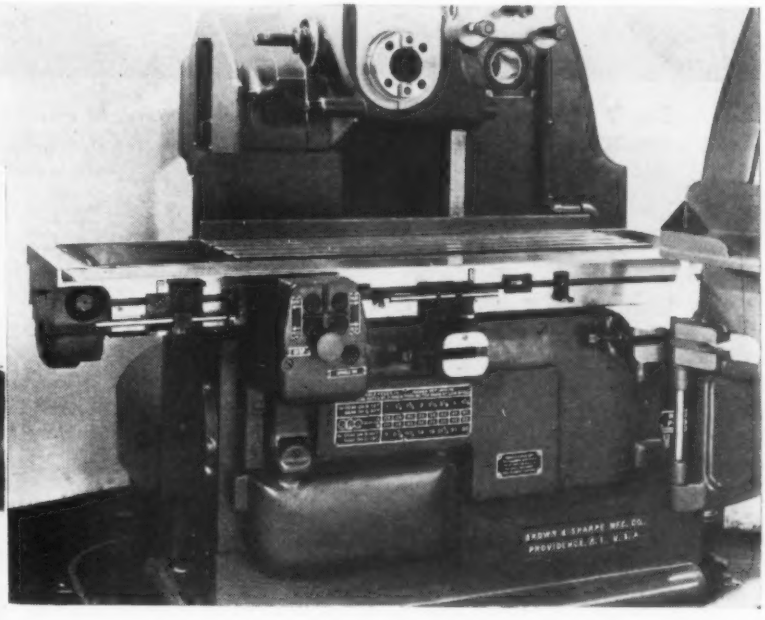


Fig. 4 (Above)—Pushbutton control unit gives full manual manipulation of machine and provides automatic cycles of operation in selected sequence of movements.

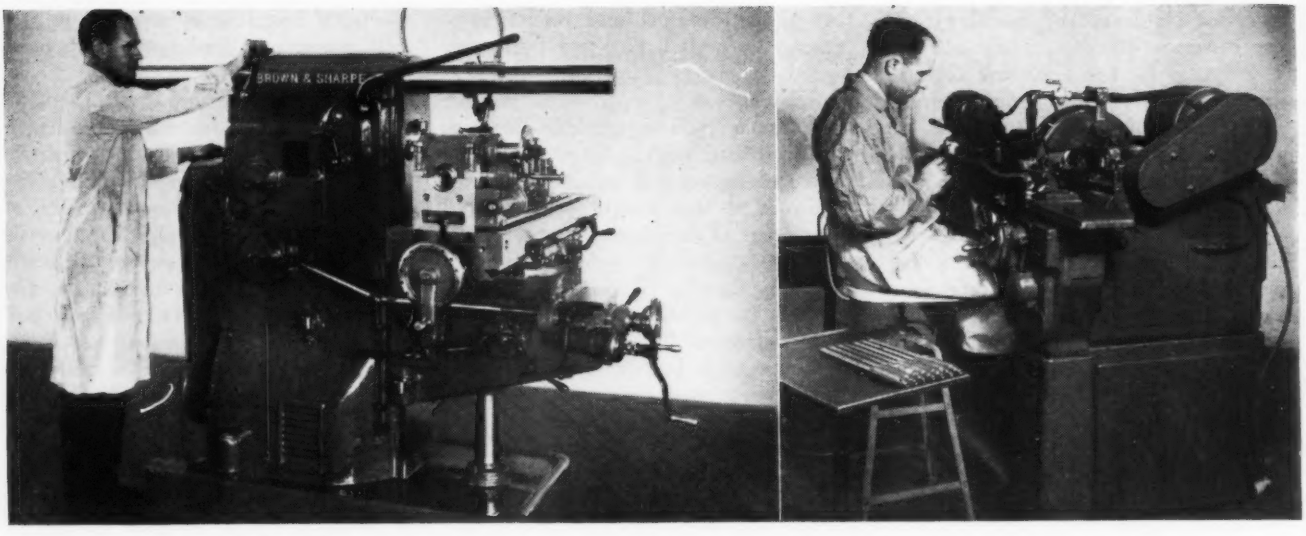


Fig. 5 (Left)—Hand crank can be used in one position to adjust one overarm, in another position to adjust the second overarm, or in mid-position to adjust both overarms simultaneously. Fig 6 (Right) — Cylindrical grinding machine designed to reduce operator fatigue to a minimum.

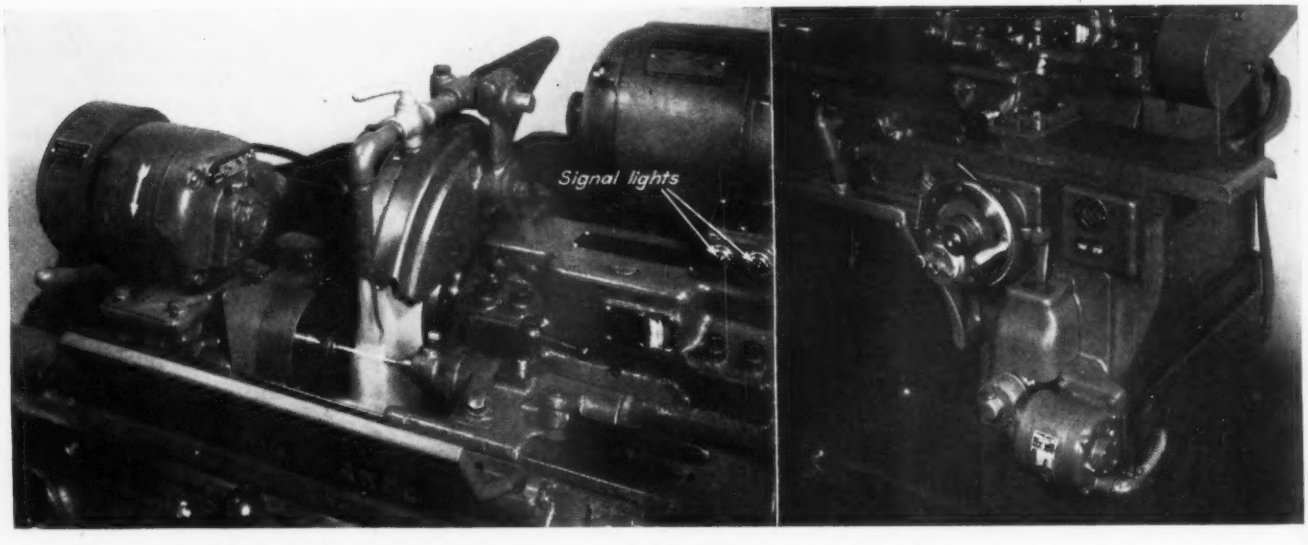


Fig. 7 (Left)—Signal lights and prevention of rapid wheel travel when truing relieve operator of many details involved in operating cylindrical grinder. Fig 8 (Right)—Independent feed arrangement on cylindrical grinder provides automatic power cross feed to the wheel slide during plunge cut operations.

The large mushroom-head stop button projects above the surface of the control post. A touch of the finger or a light blow of the hand on this button will stop the machine. All other buttons are below the face of the casting so that should an operator lean or brush against the post, the projecting stop button would be the only one depressed and would immediately stop the machine.

To prevent accidents which occur if rapid traverse should be engaged in the same direction as feed is engaged, the fast reverse dogs are provided with adjustable rods. These rods can be brought into contact with the regular feed dogs and thereby serve as a mechanical interlock which prevents the simultaneous closing of opposed electrical circuits. This prevents work spoilage and avoids damaging of cutters, work fixture and machine.

A feature of considerable convenience to the operator is the arrangement which permits easy adjustment of overarms on the large universal milling machine shown in Fig. 5. The double overarms are rather heavy and are at a substantial elevation. To prevent over exertion by the operator and to provide for easy adjustments a hand crank is employed. The crank turns pinions which engage with rack teeth cut directly on the under surface of each overarm. The crank can be used in one position to adjust one overarm, in another position to adjust the second overarm and in a mid-position to adjust both simultaneously.

The cylindrical grinding machine shown in Fig. 6 is designed to reduce operator fatigue to a minimum. The work height and operational controls are located so that they are at a convenient elevation for an operator while standing at the machine. The front of the machine is recessed to provide equally convenient operation of these same controls while the workman is seated. The foot rest surface of the opening is slightly slanting and has a ridge to provide further comfort. Such conveniences aid considerably in maintaining production and are much appreciated by women operators. The guards are designed to protect the operator while seated from coolant.

On the cylindrical grinding machine shown in Fig. 7, to obtain speed and safety in loading and unloading work

between centers, rapid wheel slide travel arrangements provide advance and withdrawal movements of the grinding wheel through a constant distance of one or two inches. This movement is in addition to the regular cross feed movement imparted to the wheel slide by the regular feed mechanism and by means of a selector switch can be used or not at the option of the operator.

Signal lights inform the operator as to the position of the wheel slide. A red light indicates the slide is back, and an amber light that the wheel slide is in forward position. To prevent undesired rapid travel movement while truing the wheel, the mechanism is automatically rendered inoperative when the "grind-true" switch is set at "true" position.

These features all contribute to economy in production for they relieve an operator's mind of many details involved in operating the machine.

Another feature which reduces movement and duty by the operator is the independent automatic cross feed arrangement on the cylindrical grinding machine shown in Fig. 8. This feature provides automatic power cross feed to the wheel slide during plunge cut operations. The motor, through adjustable linkage, actuates the ratchet wheel to advance the wheel slide to final grinding position. Whereupon the operator lifts the pawl, rotates the handwheel back to starting position which automatically returns the wheel feed, automatically engages the rapid return movement of wheel slide and automatically stops this cross feed motor.

This action avoids the danger of any accidental engagement of pawl which would automatically start the grinding operation while the operator is unloading and replacing work between centers. As the operator turns handwheel again, the cross feed motor will be automatically started and the other movements as enumerated will follow automatically in their proper sequence, with but a single manual operation on the part of the workman.

An improved and simplified arrangement of hydraulic and mechanical controls conveniently located for easy access from the normal operating position is shown in Fig. 9, on a surface grinding machine. The handwheel at the right is for manually moving the table in a transverse direction by means of a cross feed screw and half-nut construction. The power cross feed movement is obtained hydraulically, and is controlled by the long lever directly beneath the right handwheel. The lever serves as a selector for manual or power cross feed; or for the direction of power feed, that is, "in" or "out". The connections are arranged so that power is not available when hand feed is connected.

The two controls midway between the handwheels present another interesting feature associated with transverse movement. The table throttle knob is used to select the desired rate of table traverse. The control lever adjacent thereto is for truing. The truing lever is provided with a segmental locking-form which can engage a corresponding recess in the throttle knob. While operating the machine for grinding purposes the truing knob cannot be shifted because of segmental interference. When the table throttle is set to zero, the cut-out segmental portion permits the swinging of the truing lever which provides a power cross feed at a predetermined rate suitable for wheel truing, and at the same time prevents obtaining power for longitudinal table movement. The direction of the truing transverse movement is again determined by the shifting of the cross feed selector lever.

Another combined hydraulic-mechanical control is associated with the large table handwheel at the left. Manual longitudinal table movement is obtained with this handwheel by means of a rack and pinion. Power table movement is done hydraulically, it is controlled by the large ball-end lever adjacent to handwheel. Normally the handwheel is connected for table movement. When the power feed is engaged, however, the handwheel is automatically disengaged hydraulically to prevent injury which might result from the rapidly rotating handwheel. When hydraulic power to table is disconnected, the handwheel manual connections are again automatically re-established.

Such dependable interlocking connections between controls are safeguards against inadvertent or faulty operation of the machine and give an operator the comforting assurance and peace of mind that he will not spoil the work at hand, cause damage to the machine or suffer personal injury.

A safety interlock arrangement applied to a hydraulically actuated cross feed mechanism of a cylindrical grinding machine is shown in Fig. 10. The cover of the wheel adjusting case is shown in the open position to permit setting the crank to the desired graduation. Adjacent to the cover is the cross feed selector dial which can be positioned to provide: (1) Automatic cross feed with table traverse, (2) independent automatic cross feed for plunge cut work with table stationary, and (3) hand operation of cross feed from handwheel.

The dial is provided with a circular

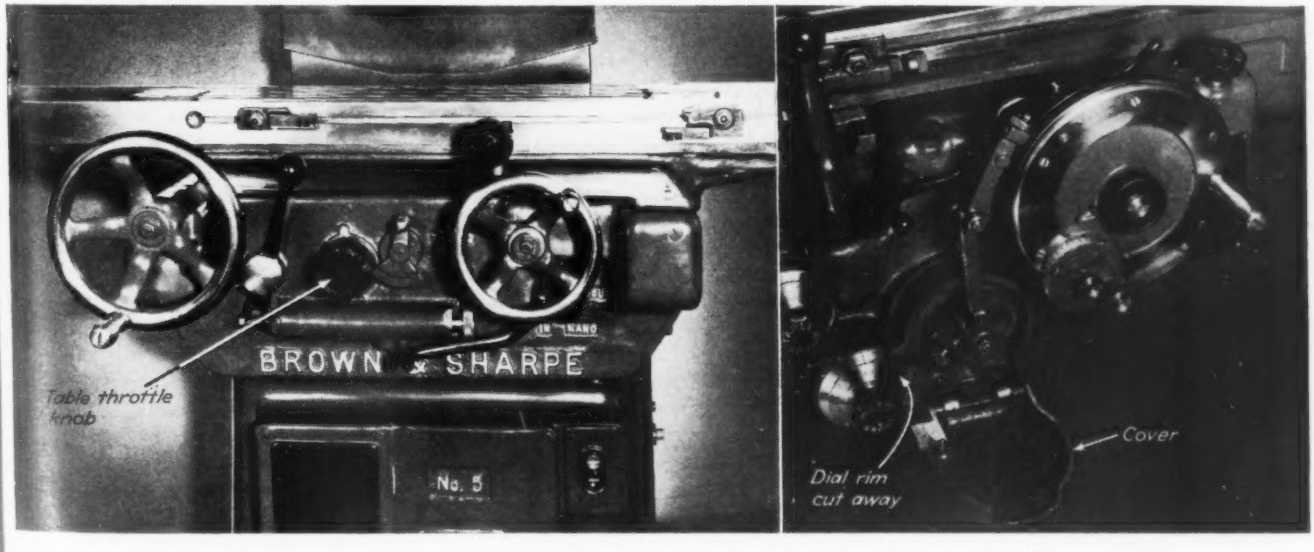


Fig. 9 (Left)—Surface grinding machine with hydraulic and mechanical controls conveniently located for easy access from the normal operating positions. Fig. 10 (Right)—Safety interlock arrangement applied to a hydraulically actuated cross-feed mechanism on cylindrical grinder.

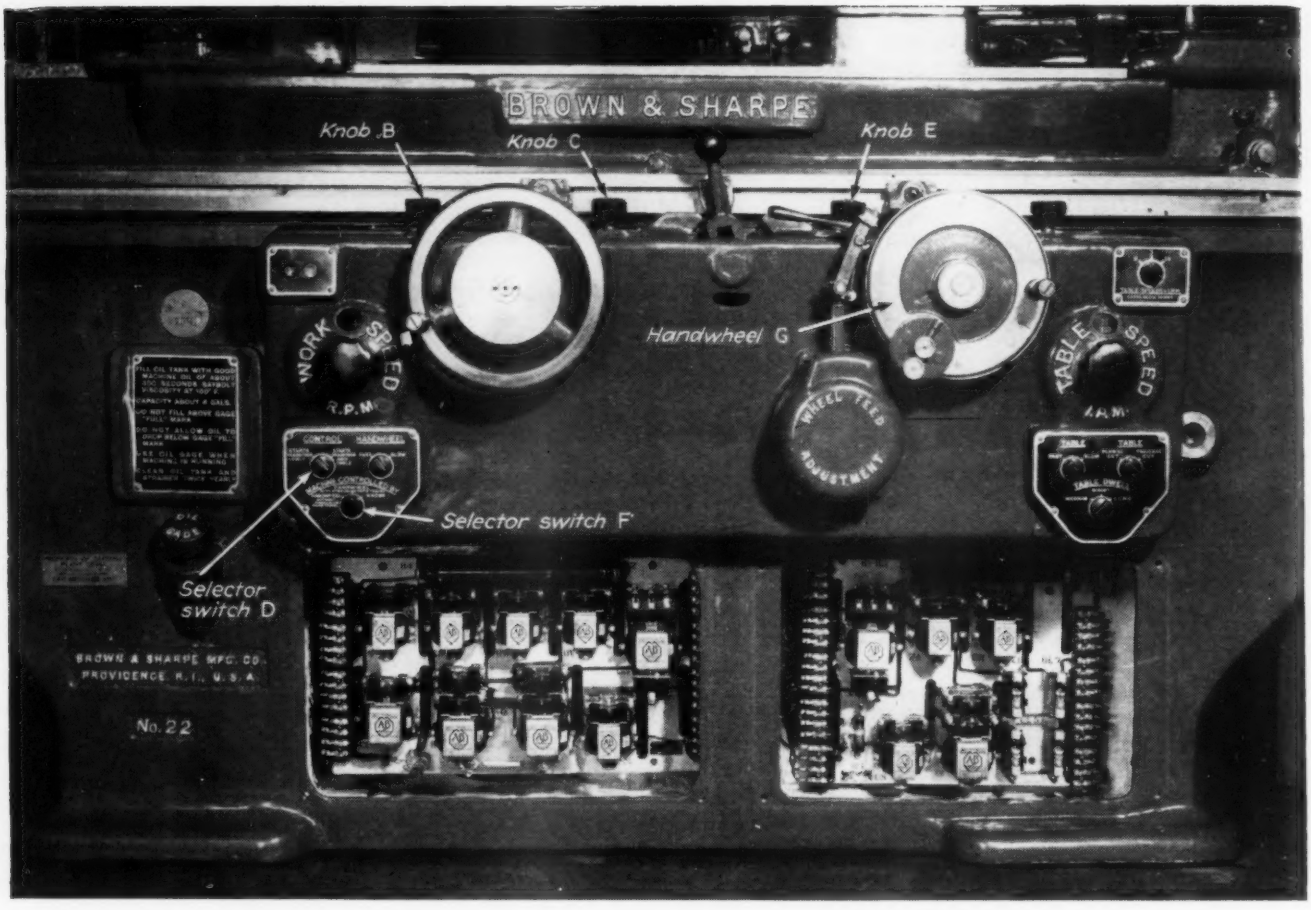


Fig. 11—Cylindrical grinder has electrical controls which can be manipulated to control one function or which can be combined to be controlled severally from the cross feed handwheel.

rim which overlaps a flange portion of the cover when the cover is closed and the cross feed mechanism is operative. A portion of this rim is cut away to permit opening the door, but the operator must set the dial to "stop" position before the cover can be opened for adjustment purposes. This interlock prevents injury which might otherwise arise at this point.

In electrically controlled and operated machines there are many operations where innumerable combinations of machine functions can be pre-selected to become effective from a single control member. Fig. 11 shows a cylindrical grinding machine provided with electrical controls that are simple and easy to operate. Each can be manipulated so as to control one function or can be combined to be controlled severally from the cross feed handwheel.

The control knob *B* when turned to the right, starts the headstock. Knob *B* when turned to the left, stops the headstock instantly. This knob can also be pressed in a downward direction to jog the headstock.

A similar knob *C* also has three functions: (1) Turning to right will start table traverse, (2) turning to left stops table instantly, and (3) pressing knob down during travel of table will cause table to stop at the end of its stroke.

The operation of headstock and table may be consolidated so as to be controlled by the headstock knob. This is obtainable through selector switch *D*, which permits the headstock switch when turned to the left position to only start and stop the headstock. With selector switch turned to the right, the headstock knob can also start and stop the table, thereby dispensing with operation of table knob.

Another knob control *E* is provided to control wheel slide rapid travel arrangement. When this knob is turned to the right, the slide will come forward, advancing the grinding wheel toward the work. Turning the knob to the left will move the wheel slide back away from the work.

The headstock knob control, table knob control and wheel slide knob control can be individually operated as desired which is a great convenience, particularly for setting-up operations. During set-up time the selector switch *F* is set to point towards the right to "Knob" control position.

With the selector switch *F* turned to the vertical position, the functions of the knobs described can all be combined to be controlled from the table handwheel so that as the handwheel *G* is turned to the left the wheel slide will be automatically brought forward at a rapid rate, the headstock rotation will be automatically started, the flow of coolant will commence and table reciprocation will take place. When work is completed rotation of this handwheel back to its original position will automatically return wheel slide, stop the headstock, apply the headstock brake, stop the table travel and stop the flow of coolant on the work.

By turning the selector knob to the extreme left, the wheel slide rapid travel movement may be excluded from the semi-automatic cycle which is operative from the cross feed handwheel.

Versatility of control is a labor-saving feature which permits sustained high level of production from machine and operator with a minimum of operator fatigue and work spoilage.

Of the many factors that enter into design of future machines, the elimination of operational hazards, the reduction of operator fatigue and elimination of tedious manual operations will be of outstanding importance inasmuch as they play a prominent part in operating efficiency and the reduction of costs.

Properties and Workability Of 75S Aluminum Alloy

M. RASKIN
Assistant Chief Process Engineer, Northrop Aircraft, Inc.

Discussion of the heat-treatments and forming limitations of high-strength 75S aluminum alloy as compared to the 24S alloy, and methods by which difficulties are overcome.

COMMERCIAL production of the now vitally important high strength aluminum alloy 75S was awaited impatiently by manufacturers. The urgency to use this highest strength aluminum alloy as soon as possible was such that its fabrication qualities and peculiarities were intensively investigated even before the alloy was commercially obtainable. Since only physical properties and corrosion resistance were known, such important questions as the following had to be answered:

1. Is the strength of the material consistent? If not, can controls be established to weed out undesirable material?

2. How important is heat-treatment of this alloy? What procedures are required to control temperature, quench methods, and the extent of warpage? What are the difficulties in reworking, preheating and annealing?

3. What are its general forming characteristics: bend radius allowances, stretching and shrinking, performance in hydraulic press and drop hammer, in beading, joggling and plannishing?

4. Will there be problems in dimpling and riveting, and how can they be solved?

5. Will conventional spot welding and fusion welding be practical in production? If not, can satisfactory welding procedures be developed?

Neither the shop nor the engineer could afford to discover after many designs had been released that the material was too difficult to handle or that it would fail in service.

Results of hundreds of tensile tests proved that 75ST is unquestionably the strongest Alcoa aluminum alloy yet developed, as indicated graphically in Fig. 1. Several test specimens were found to have tensile properties exceeding the minimum values of normalized 4130 steel. Minimum specification strength requirements are now always exceeded although the first material received, known as XA75ST, in gages up to 0.040 in., did not have the required strength and lacked consistency. Faulty material was prevented from reaching the production line by establishment of careful control, using selective Rockwell charts and laboratory tests to check properties.

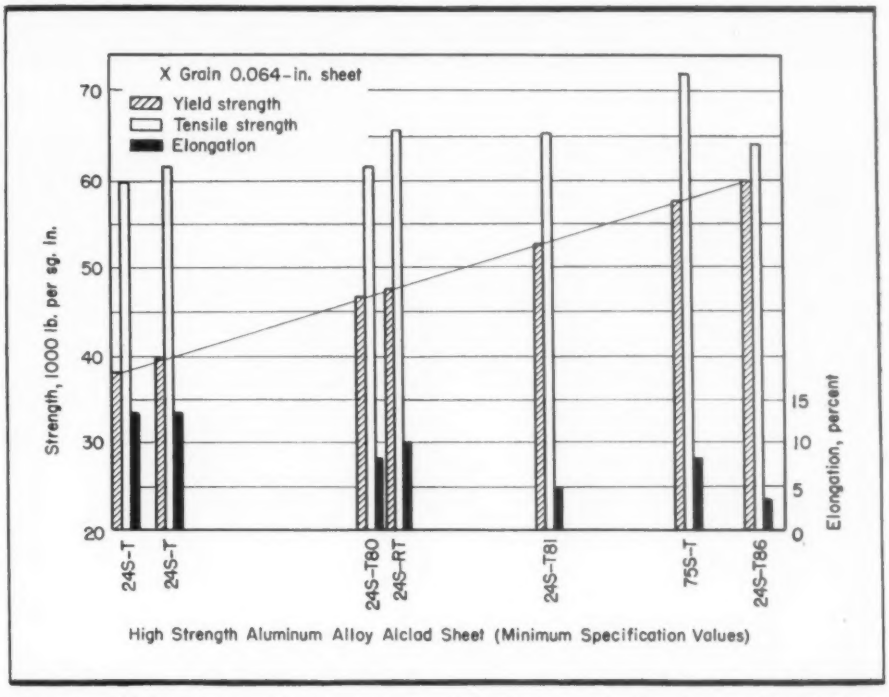


Fig. 1—Minimum specification values of high strength aluminum alloy Alclad sheet. Some values exceeded minimum values for normalized 4130 steel.

Heat-Treatment

Consistent properties are obtained by two heat-treating operations, a solution and an aging treatment. The former is the same as that employed on 24ST. The latter consists in soaking at 250 deg. F. for 24 hr. If maximum physical properties are desired, the aging treatment must begin within two hours after the solution heat-treatment or two days must elapse before the aging treatment begins. The long aging heat-treatment and the time interval between heat-treatments may be eliminated in the near future by substituting a progressive aging treatment consisting of heating 75SW material for 4 hr. at 212 deg. F., then raising the temperature to 315 deg. F. for 8 hours.

Since the cladding does not have the same tendency to dissolve into the parent metal of 75S as into 24S, 75S can safely be soaked longer and reheated more often. The solution heat-treatment has a tendency to discolor 75S clad material. The objections to the discoloration are the tendency to confuse it with diffusion of the cladding and unsatisfactory finish appearance. The 75S material remains soft at room temperature for about 40 min. after the solution heat-treatment quenching, or indefinitely if maintained at 0 deg. F. or at lower temperatures. This temporary state of softness has become generally known as the "as quenched" condition.

On the unfavorable side 75S must be rapidly quenched in water. Air quenching or "delayed" quenching

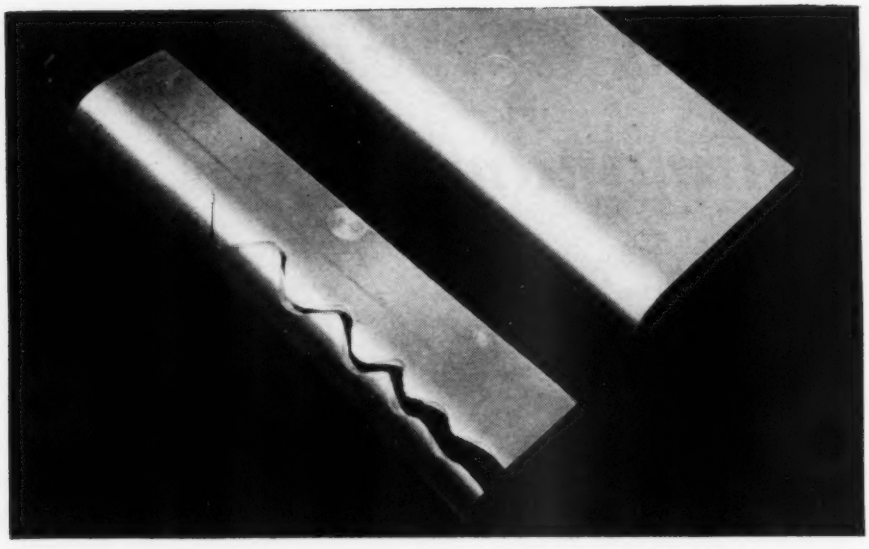


Fig. 2—Typical failure in bending 75ST Alclad. Specimen is 0.091 in. thick.

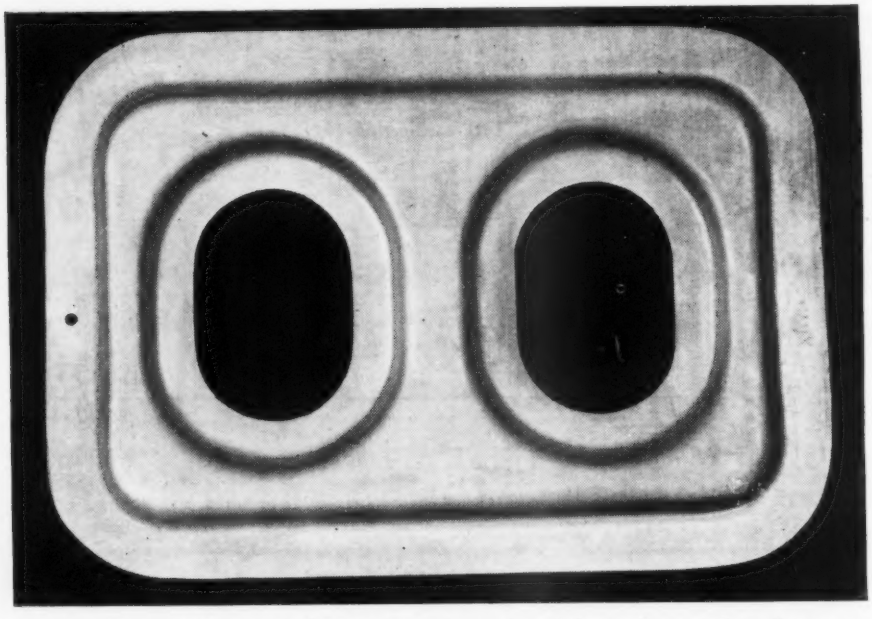


Fig. 3—Door stiffener of 75SO Alclad sheared and formed on a drop hammer.

drastically lowers physical properties. Although heat-treat warpage is no greater than in 24S, 75S hardens much more rapidly at room temperature after the "as quenched" condition is passed. This means that check and straightening operations must be done without delay after completing heat-treatment.

Forming Properties

Forming properties of 75ST are much inferior to those of 24ST, as might have been predicted from its high yield strength and small plastic range. The high degree of springback and low ductility prevents the use of standard forming practices and tooling, which were used for making the bend shown in Fig. 2. Compression forming or shrinking properties are especially poor. Scratches that merely penetrate the cladding and are only a few ten-thousandths of an inch deep cause failures when they are parallel to the bend. The necessity for burring and polishing of edges was found to be more critical with other aluminum alloys. These facts on notch sensitivity have made the shop "notch cautious" and have prevented scrapping many parts.

As a result of formability tests of 75S in the SO, AQ (as quenched), and SW conditions, many parts have been formed satisfactorily, starting with a temper based upon the extent of formability required. Forming tests for SW material indicate new possibilities. The material becomes fairly stable in the SW condition approximately one week after receiving the solution heat-treat quench. The increase in yield strength of 75SW after one week ranges from 100 to 300 lb. per sq. in. per week if a temperature of approximately 70 deg. F. is maintained. At this rate the material will increase in yield strength approximately 6,000 lb. per sq. in. in one year. Yield strength of 75SW will thus be considerably below the minimum for the 75ST condition and be accordingly more ductile. This gradual change in yield strength makes springback difficult to predict, but general ductility is still superior to 75ST. Parts formed in the SW condition do not require rapid working and can be brought to the ST condition by means of the low temperature non-warping aging treatment.

Hot forming, up to 325 deg. F. for a limited time, is also being employed successfully in production, especially in "forming emergencies," without reducing strength of the material. Hot forming of 75ST proved to be very successful whenever heating equipment could be adapted to the particular part.

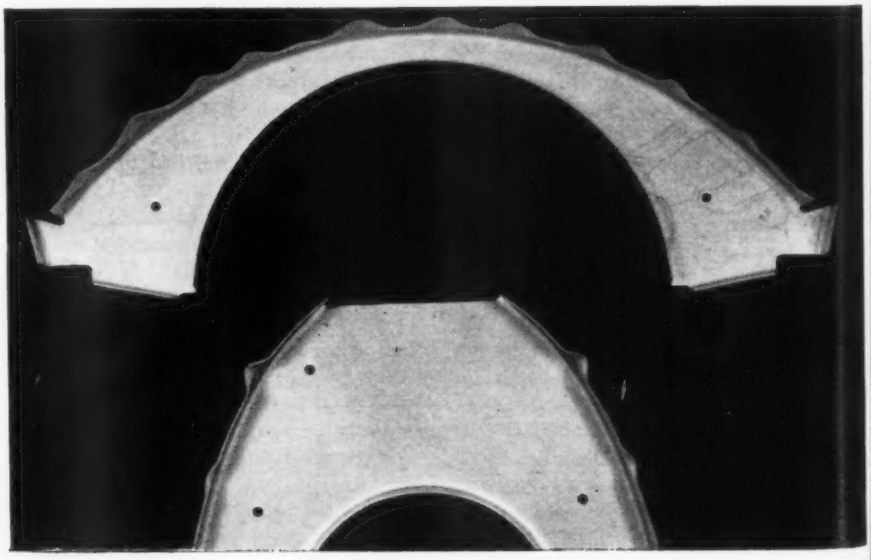


Fig. 4—Typical hydraulic press formed parts.

The basic problem in hot forming is to complete the forming operation before the part loses too much heat. To accomplish this, Northrop employs resistance heating, heated dies, portable and stationary ovens.

Although greater pressures are required, good results have been obtained with 75S in the SO and AQ conditions in hydraulic press and drop hammer forming. Parts in Figs. 3 and 4 were formed in this way.

Dimples for Rivet Heads

The forming of dimples for rivet heads was a major production problem. Unlike general forming, in which the radius or condition of hardness can vary, a dimple must conform to the shape of rivet heads and be formed in the ST condition. Both radial and circumferential edge cracks, shown in Fig. 5, are difficult to avoid. Dimple failures are often invisible on the surface even after etching and magnifying. Insidious cracks that cause shear failures occur inside the dimple wall, as shown in Fig. 6. Although the problem seemed insurmountable, satisfactory dimples are now being made in production by a new method, which was developed especially for this material.

In the new method of dimpling 75ST a pneumatic compression riveting machine with an electronic timer, 18 kva. d.c. welding transformer, and special tool holders are used. The dimpling is done hot by means of electric resistance. This machine can dimple 75ST in rivet and screw sizes from $\frac{3}{32}$ to $\frac{5}{16}$ in. and in gages up to 0.102 in. Exceptionally flush surfaces are produced and dimples are sound, free of cracks, and stronger than cold dimples.

Parts that cannot be brought to the hot dimple machine are dimpled cold. The cold dimple has a generous radius and is so dimensioned as to prevent cracking and internal strains, as well as to nest with the hot dimple when the two are lapped.

The helium shielded arc can be used in welding 75ST but the resultant weld has poor corrosion resistance and tends to be brittle after reheat-treatment. However, the tensile strength of the reheat-treated weld approaches that of the parent material. Spot welds are satisfactory. Design limitations and welding practices for 75ST aluminum alloy are similar to those used in spot welding 24ST Alclad.

Thousands of miscellaneous 75S parts and assemblies have been made for Northrop's XB35 airplane with no greater scrap loss than with similar parts made of 24ST aluminum. As a result of Northrop's early experience and success in applying the material, the Crenshaw plant has been visited by hundreds of engineers and production men, seeking information on the fabrication of 75S aluminum alloys.

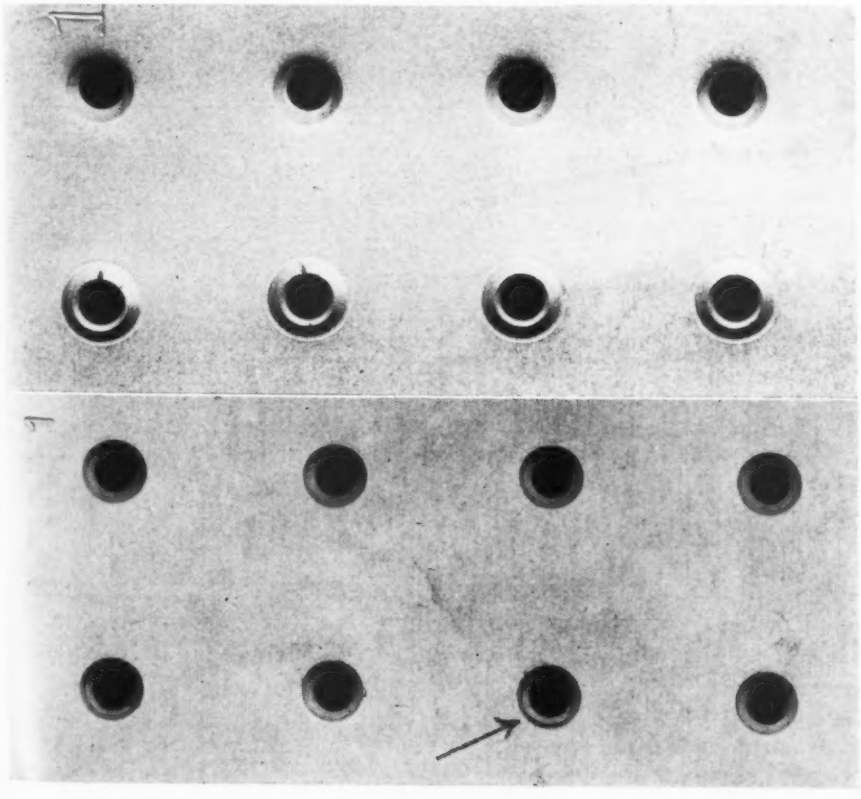
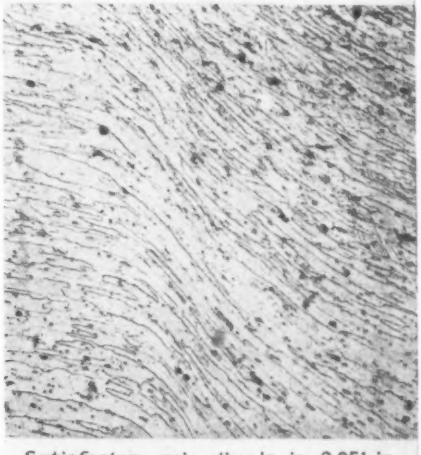


Fig. 5—Etched 75ST Alclad dimpled sheet showing radial and circumferential edge cracks in dimples made with modified standard tools.

External wall dimple crack produced by standard 24ST dimple tool in 0.051-in. 75ST Alclad

Internal wall dimple crack produced by standard 24ST dimple tool in 0.051-in. 75ST Alclad



Satisfactory coin dimple in 0.051-in. 75ST Alclad

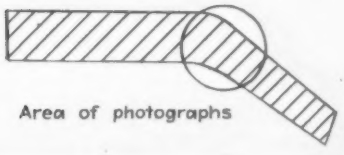


Fig. 6—External and internal wall dimple cracks produced by standard 24ST dimple tool, and satisfactory structure produced in a coined dimple.

Strength of Spot Welds In 75S Aluminum Alloy

SPOT welding tests by Consolidated Vultee Aircraft Corporation on 75S aluminum alloy after both solution heat-treatment, the "W" condition, and after complete heat-treatment, the "T" condition, show that satisfactory welds with consistent strength can be made without establishing optimum welding machine settings for different gages of material. Shear strengths are higher than the minimum required for clad 24ST aluminum, as shown graphically in Fig. 1. Tables I and II show the consistency of ten shear values and the welder settings used. Tables III and IV give comparable data for R301 aluminum in the "W" and "T" conditions.

Tests consisted in spot welding 10 specimens each of three thicknesses of 75S aluminum alloy sheet in the two heat-treated conditions; 60 welds in all. Forty spot welds were made in the R301 material. Specimens were 1 x 4 in. pieces, lapped approximately 1 in. and held together by a single spot. Tips of welding electrodes were cleaned every five spots, which may have been more frequent than necessary. No spitting or cracking occurred during welding.

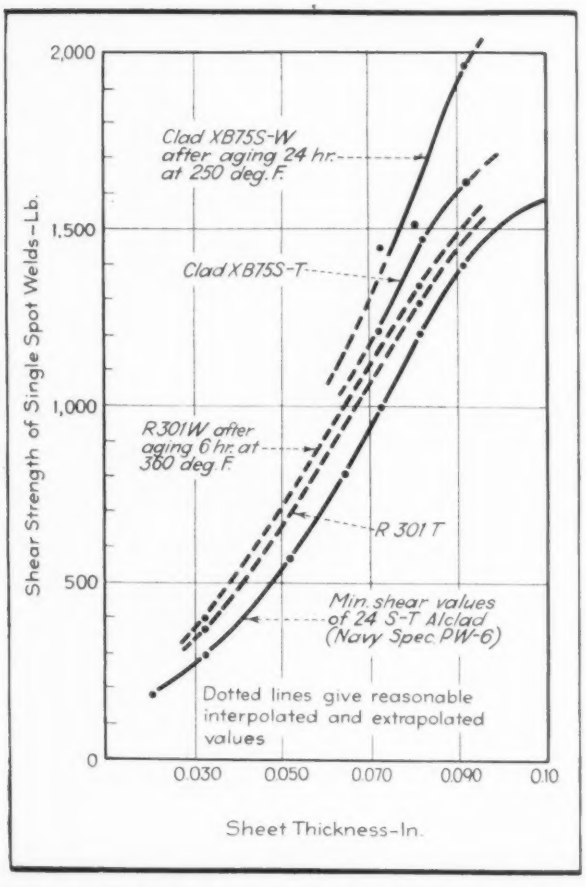


Fig. 1—Curves indicate that shear strengths of spot welds in 75S aluminum are higher than the minimum required for clad 24ST aluminum.

Table I—Characteristics of Spot Welds In XB75ST Clad Aluminum
(10 welds in each gage)

Gage in.	Shear in lb. Max.	Shear in lb. Average	Shear in lb. Min.	Consistency, percent Max. Variation
0.072	1,325	1,203	1,050	12.70
0.081	1,650	1,474	1,400	11.90
0.091	1,800	1,631	1,420	12.90

Welder Settings

Gage in.	Tip Pressure lb. per sq. in.	Squeeze Time sec.	Number of Capacitor	Voltage	Slug Dia. in.
0.072	1,850	0.4	31	2,200	9/32
0.081	1,880	0.4	31	2,550	19/64
0.091	2,360	0.4	44	2,550	21/64

Table II—Characteristics of Spot Welds In XB75SW Clad Aluminum
(Spot weld in XB75SW condition, then aged 24 hr. at 250 deg. F; 10 welds in each gage)

Gage in.	Shear in lb. Max.	Shear in lb. Average	Shear in lb. Min.	Consistency, percent Max. Variation
0.072	1,560	1,447	1,350	7.80
0.081	1,620	1,510	1,350	10.60
0.091	2,295	1,977	1,800	16.10

Welder Settings

Gage in.	Tip Pressure lb. per sq. in.	Squeeze Time sec.	Number of Capacitor	Voltage	Slug Dia. in.
0.072	1,720	0.4	31	2,200	9/32
0.081	1,660	0.4	31	2,500	19/64
0.091	2,230	0.4	44	2,550	21/64

Table III—Characteristics of Spot Welds In R-301 T Aluminum
(10 welds in each gage)

Gage in.	Shear in lb. Max.	Shear in lb. Average	Shear in lb. Min.	Consistency, percent Max. Variation
0.032	400	370.5	330	10.80
0.081	1,355	1,286	1,215	5.52

Welder Settings

Gage in.	Tip Pressure lb per sq. in.	Squeeze Time sec.	Number of Capacitor	Voltage	Slug Dia. in.
0.032	700	0.3	5	2,100	5/32
0.081	2,030	0.4	31	2,400	19/64

Table IV—Characteristics of Spot Welds In R-301 W Aluminum
(Spot weld in R-301 W condition, then aged 6 hr. at 360 deg. F.; 10 welds in each gage)

Gage in.	Shear in lb. Max.	Shear in lb. Average	Shear in lb. Min.	Consistency, percent Max. Variation
0.032	420	379.5	355	10.70
0.081	1,455	1,330	1,250	9.40

Welder Settings

Gage in.	Tip Pressure lb. per sq. in.	Squeeze Time sec.	Number of Capacitor	Voltage	Slug Dia. in.
0.032	650	0.3	5	2,100	5/32
0.081	1,800	0.4	31	2,400	19/64

Design of Hydraulic Systems

VII—Power Systems

HOWARD FIELD, JR.
Consultant

Analysis of basic power systems and their characteristics when used for intermittent and continuously loaded hydraulic systems. The author discusses unloader, full-pressure, variable-volume and open-center power systems and indicates the problems involved in a few simple combinations of these systems.

HYDRAULIC systems should be adapted to the specific conditions of the problem under consideration. Although the designer must always consider the system as a single unit, any hydraulic system can be divided into two parts—the power system and the distribution system—for convenience of discussion.

The simplest power system consists of a hand-operated pump, a reservoir for fluid, and a means to prevent the development of extreme high pressures. Excessive pressures can be prevented by so proportioning the pump and handle that a man is incapable of exceeding safe pressures or by installing a pressure-relief valve.

A power-actuated pump becomes necessary when the power required is greater than a man is capable of supplying or it is inconvenient for a man to operate the pump. When the maximum power required is low, say 1/10 to 1/5 horsepower, and the cost to obtain this power is low it may be satisfactory to use a simple relief valve to limit the maximum pressure in the system. This is seldom economical in any system where power is developed continuously and used intermittently since it is thrown away as heat. A pump has shorter life when operating at full pressure than at low pressure.

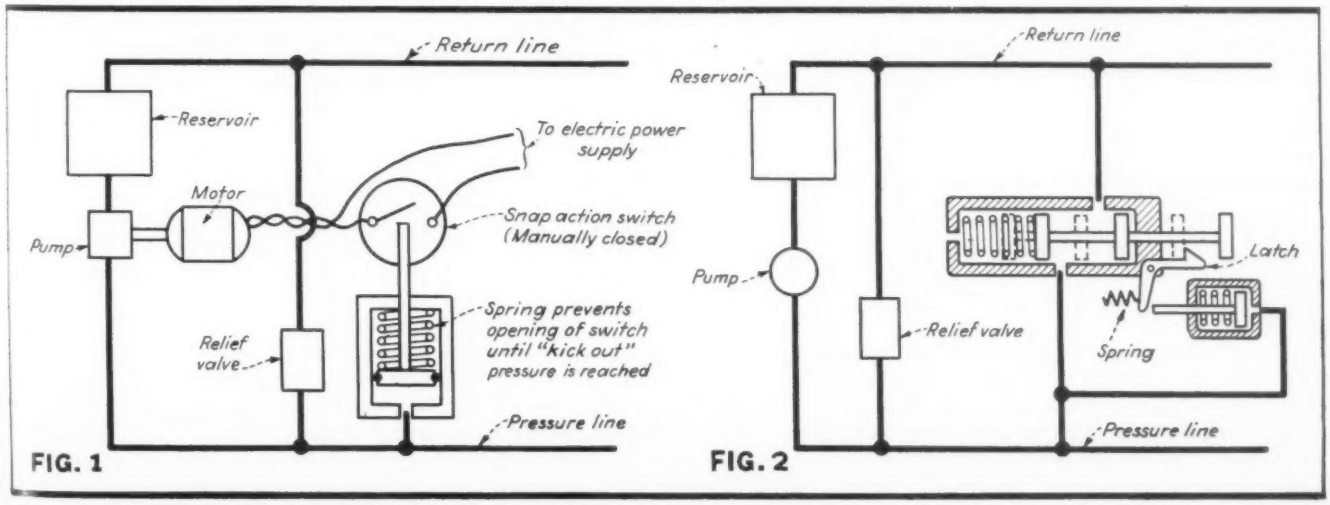
In some hydraulic systems it is possible to drive the pump by an electric motor which is turned on when hydraulic actuation is needed and turned off when the operation is completed. Experience has shown that few operators will turn the motor off, especially when they expect to use it again in a few minutes. This can be overcome by the use of an automatic pressure switch arrangement as shown in Fig. 1. The pressure switch is set to turn off at a pressure slightly higher than that required for operation of the hydraulic function and the relief valve is set to a higher pressure. The relief valve is purely a safety device to prevent damage if the switch should fail to operate.

This scheme requires the "kick-out" pressure to be excessive for operations which are subject to external accelerations as, for example, aircraft landing gear retraction. The external acceleration causes a transient increase in the pressure at the operating cylinder which is transmitted back, thus opening the pressure switch. This power system is obviously ill-suited to the operation of devices which require a continuous supply of fluid under pressure.

A variant of this scheme is to use a continuously operating pump and to return the output at low pressure to the reservoir when hydraulic operations have been completed. A by-pass valve, Fig. 2, is manually closed when pressure is desired. When the pressure builds up to greater than normal intensity the valve opens automatically. This variant has no advantage over the earlier version except that the pump can be directly connected to some large prime mover which is required to run continuously.

There are many hydraulic systems which are infrequently operated although the pumps run continuously. If

Fig. 1—Automatic switch arrangement used when intermittent operation is required.
Fig. 2—Pressure opened by-pass valve returns the continuously operating pump's output to the reservoir, at low pressure, when operations are completed.



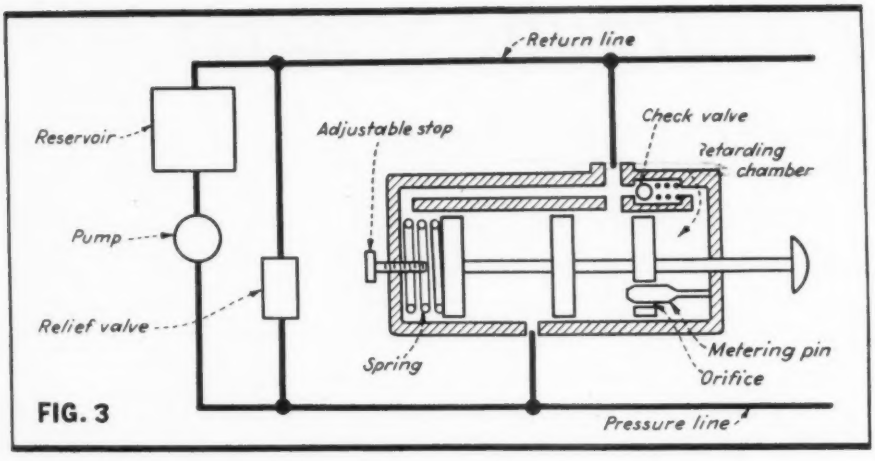


Fig. 3—Manually operated time-delay automatically opens, to by-pass pump output, after a preset time interval.

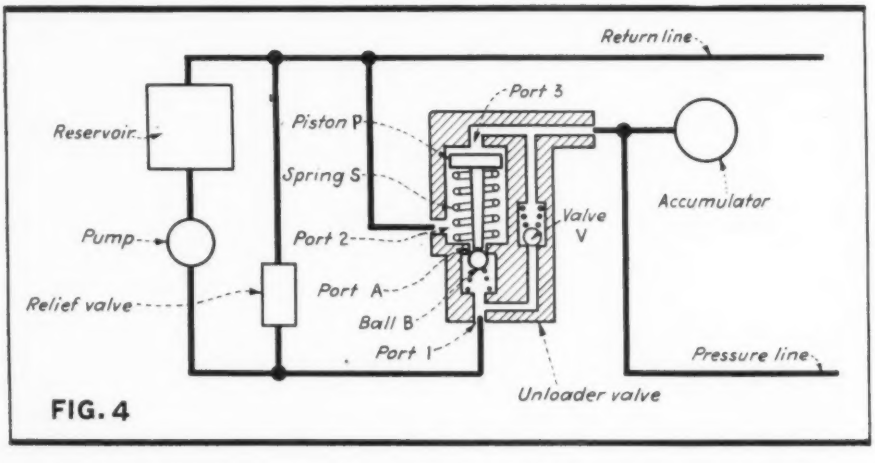


Fig. 4—Conventional unloader system in which the pump runs free when pressure in the distribution system reaches a predetermined pressure.

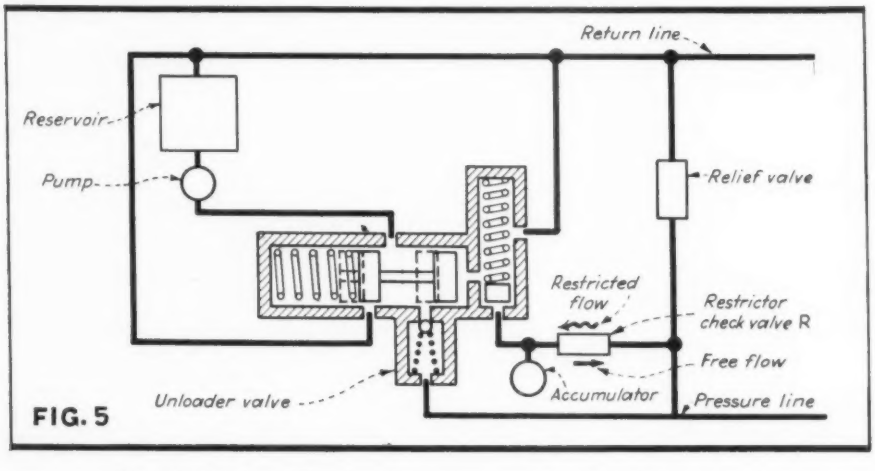


Fig. 5—Cushioned unloader system requires a restrictor check valve and a separate control line to the unloader valve.

the period of operation is short, say two minutes maximum, a good method of relieving the pressure is to install a by-pass valve which automatically opens a definite time after having been manually closed. The dwell must be slightly longer than the operating time of the hydraulic function and a relief valve must be included to prevent excessive pressures.

The time delay by-pass valve, Fig. 3, consists of a balanced shut-off valve which is urged toward the open position by a spring. The action is delayed by trapping fluid behind a piston and letting it escape slowly through an orifice. It is advantageous to arrange a metering pin in the orifice so that the motion is slow for the first part of the opening stroke but becomes rapid as the valve opens. This gives a valve which is positive in action and serves to keep the small orifice clear of dirt. The retarding chamber is filled from the return line through a check valve whenever the by-pass valve plunger is moved to the closed position. Time adjustments can be made by changing the metering pin, the spring force, and a variable stop which limits the distance the plunger can be depressed.

None of the foregoing power systems is suitable for an installation having a continuous or large but infrequent demand. It is usually more economical in the latter case to use a small pump working continuously and store power in an accumulator, than to use a pump of sufficient capacity to satisfy the demand. Other considerations such as space, weight or safety in case of damage, may force the choice of the less economical large pump under some circumstances. Another factor militating against these power systems is the necessity for the operator to do two things; turn the proper selector valve to the desired position, and turn on the power. For "pressure kick-out" systems it is necessary to position the selector valve before turning on the power.

A fully automatic power system reduces the operator's duty to the simple turning of a selector valve. The earliest and the most universally used automatic system is one form of the full pressure type which is known as the "unloader" system. The unloader system is basically one in which the pump runs free, unloaded, whenever the pressure at the distribution system is above a predetermined minimum. The conventional unloader system is diagrammed in Fig. 4. When the by-pass or unloader valve is closed the pump supplies fluid pressure to the distribution system and the accumulator. When the valve is open the pump output is short circuited at low pressure to the reservoir. The relief valve is purely a safety device to prevent the development of excessive pressure should the unloader valve fail to function with sufficient rapidity.

The unloader system, shown in Fig. 4, has the unloader valve in the closed position. Pressure fluid from the pump enters at port *1* but is prevented from escaping to port *2* and the reservoir by ball *B* which is seated in the internal port *A*. Pressure fluid from the distribution system and accumulator enters port *3* and tends to force the piston *P* downward thus lifting ball *B* from its seat. This tendency is resisted by the heavy

spring *S* plus the force on the ball *B* resulting from the pressure on its lower side. Since the area of the piston is larger than that of the ball increasing the pressures in ports *1* and *3* will eventually result in lifting the ball a small distance off its seat *A*. This causes a drop in pressure in port *1* because some fluid can easily escape through port *2*.

The sudden reduction in the upward force on the ball *B* unbalances the piston and the resulting downward force and movement of the piston complete the opening of the ball valve. The check valve *V* prevents backflow from the distribution system to the power system. As pressure in the distribution system gradually falls, the piston *P*, under the action of the spring *S*, gradually rises.

When the ball *B* approaches its seat a pressure drop resulting from the fluid flow occurs. This causes an upward force on the ball *B* suddenly closing port *A* at a pressure which will be lower than that at which it opens. This difference is known as "range" and can be varied in amount by change of the relative diameters of the piston *P* and the port *A*.

The type of unloader system in Fig. 4 has two principal disadvantages. When the pump has larger capacity than is required for some function the unloader can open and close rapidly while that function is being performed. When the pump is just large enough and the accumulator is a little too small completion of the operation may be delayed because the pump must furnish fluid for both the operation and recharging the accumulator. This is particularly true if the operation starts at low pressure but ends at high pressure.

A variant of the former system known as the "cushioned unloader" system is shown, together with a different type of unloader valve, in Fig. 5. The basic difference between the circuits of Fig. 4 and Fig. 5 is the provision in the latter of a restrictor check valve *R* and a separate control line to the unloader valve. The restrictor check valve permits rapid discharge of the accumulator to the distribution system but allows only slow recharging by the pump. This prevents rapid opening of the unloader and assures that the major portion of the pump discharge is available to perform the operation in progress. Any fluid pumped in excess of the total requirement of the operation plus the accumulator recharging is by-passed through the relief valve. The particular unloader valve shown is pilot operated although any unloader valve having a separate control port can be used.

A further variant of the unloader system, but one which can only be used with pumps designed to withstand operation with their intake passages closed, is illustrated in Fig. 6. This type of unloader valve is suddenly operated, as the valves previously discussed, by the pressure in the distribution system. Unlike the previous valves it closes when cut-out pressure is reached and thus stops the flow of fluid into the pump inlet. Naturally the pump requires only enough power to overcome friction when it is rotating without pumping fluid.

Another type of full pressure power system is known as the "variable-volume" system. In diagrammatic form it is somewhat less complicated than unloader systems but the pump is generally more complicated. The pump used with this system must be of a type whose discharge volume at constant speed can be varied from zero to maximum. The usual form of the variable-volume system is shown in Fig. 7. In this form the pump is of the variable-stroke type and is urged toward zero stroke position by a hydraulic cylinder connected to the pump discharge line. It is urged toward full stroke position by a spring which is arranged to give the desired characteristic to the pressure-volume relation. In some systems it might be desirable to have the volume change inversely as the pressure while in others it might be better to hold the volume constant until a high pressure is reached and then rapidly approach zero as the pressure further increases. The second characteristic can be accomplished by preloading the spring.

A variation of this type of system uses a variable stroke pump arranged so that the bearing reaction caused by eccentricity is balanced by a spring. At any one stroke, eccentricity, the reaction is directly proportional to the pressure so that this variation gives a means of eliminating the hydraulic stroke control cylinder. Unfortunately, the gain from this elimination is offset by the additional complication in the pump structure.

Another variation in the variable-volume power system is similar to the unloader system in Fig. 6. If the unloader valve of that system is replaced by a valve which closes slowly and limits the amount of fluid reaching the pump intake in proper relation to the pump discharge pressure the result is a variable-volume power system with a fixed stroke pump. It should be pointed out again that the pump must be designed to run partially starved, or trouble may ensue.

All of the foregoing power systems are particularly adapted for supplying fluid under pressure to operations which do not have close time limitations. A flow-control valve is used in conjunction with these power systems when the rate of operation of some function is roughly limited by time or by approximate relation with other functions in the whole installation. When exact control of the rate of operation is necessary flow-control valves are generally not suitable. Under these conditions it

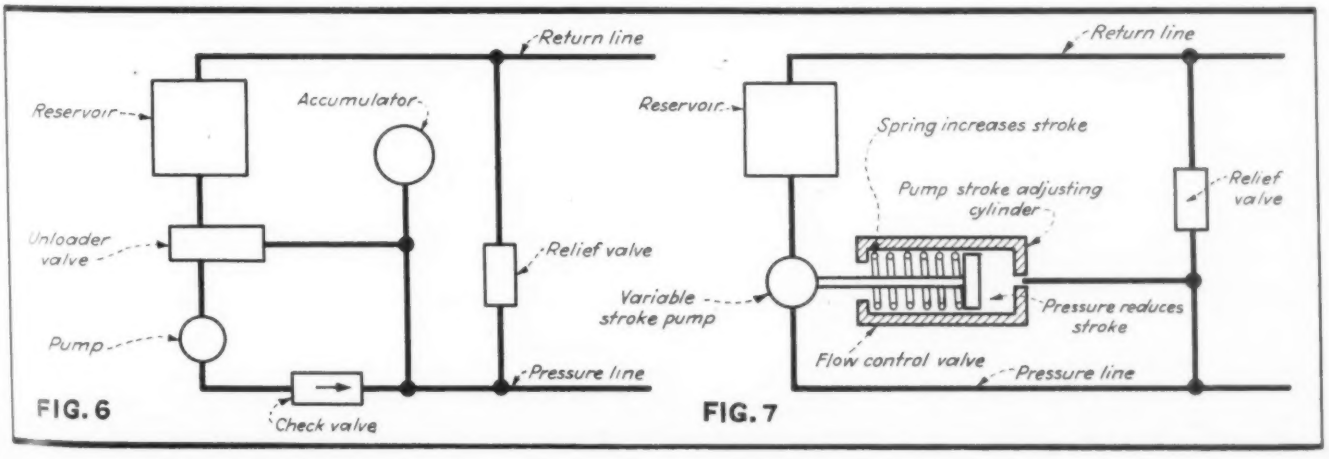


Fig. 6—Unloader system using an unloader valve placed in the pump inlet. Fig. 7—Variable Volume system requires a pump the output of which can be changed during constant speed operation.

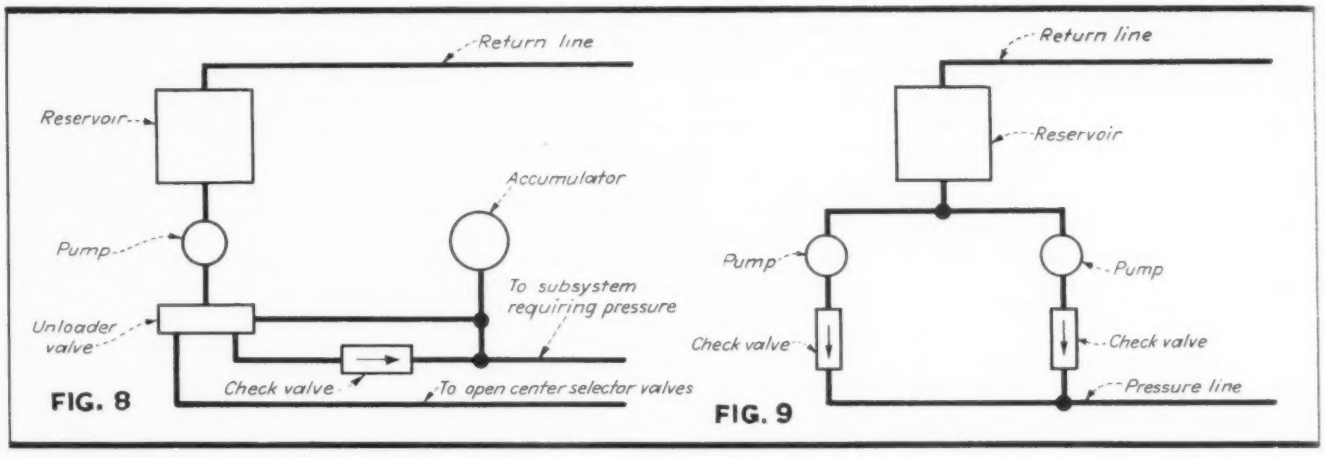


Fig. 8—Open-center system in which the unloader valve is aperated by some subsystem. Fig. 9—Arrangement of two pumps to supply normal hydraulic services where one pump can be used to handle reduced output.

is advisable to use a variable stroke pump the maximum stroke of which can be closely controlled. It is often convenient to superimpose the close control of stroke upon a variable-volume system as in Fig. 7. Then, if the closely regulated operations are carried out at pressures well below the working pressure of the pump at reduced volume, a satisfactory system results. Fine-feed systems on machine tools can be made in this manner.

Another general type of power system is the "open-center" system. This power system is affected to an extreme degree by the distribution system. However, it is quite common to superimpose some features of other power systems upon it. In brief, it consists of a system in which flow is continuous from the pump, through lines, through open valves, and back to the reservoir at full volume but low pressure. When a selector valve is moved from the neutral position this free flow circuit is interrupted and pressure is built up. Obviously this type of power circuit is not suitable when there is a continuous need for power or when power must be stored for instant use in some subsystem. This condition can be realized if an unloader system is used in connection with the open-center system.

In this case the subsystem is arranged to operate solely from the unloader portion of the power system. Fig. 8 shows an arrangement used to secure the desired result. When power is not being used in any portion of the system the flow of fluid is from the reservoir to the pump, through the open unloader valve, through the open center selector valves and back to the reservoir. When the pressure in the accumulator falls below some predetermined intensity the unloader valve closes, thus pressure builds up and recharges the accumulator. The accumulator is also charged when any selector valve is turned from the neutral position. A disadvantage of the system is that whenever the unloader valve closes the entire pump output is diverted to recharging the accumulator and all other parts of the distribution system are inoperative.

If recharging the accumulator is of less importance than some other functions, it is possible to install the unloader valve downstream from the selector valves controlling the more important functions. This has no advantage if ordinary open center selector valves are used because the back pressure caused by closing of the unloader would prevent the operation controlled by the selector valve. This can be overcome by using so-called "Five Port" selector valves, which will be discussed in another article.

The power systems discussed have been simple in form. The combination of the unloader and open-center systems is the first step toward the complications which can occur when an attempt is made to force a single pump to supply fluid for two or more systems having totally different characteristics. This is a problem which usually can be solved in a satisfactory manner by the simple expedient of avoiding it. For example, in the case of the superimposed systems a better solution might have been obtained by using an entirely separate electrically driven pump to charge the accumulator. The pump could have been turned on and off by a simple pressure operated switch and neither system would have been handicapped by the presence of the other.

The other way to avoid the dilemma is to set up the power system to best suit the characteristics of the most important or largest service and then design the less important services to match the established characteristics. It is only in cases where the problem cannot be avoided economically that additional complications are justified.

Another set of design problems arise when because of reliability, size of available units, irreconcilability of characteristics, or required flexibility of operation, more than one pump is advisable. It must first be decided how the pumps are to work together, then

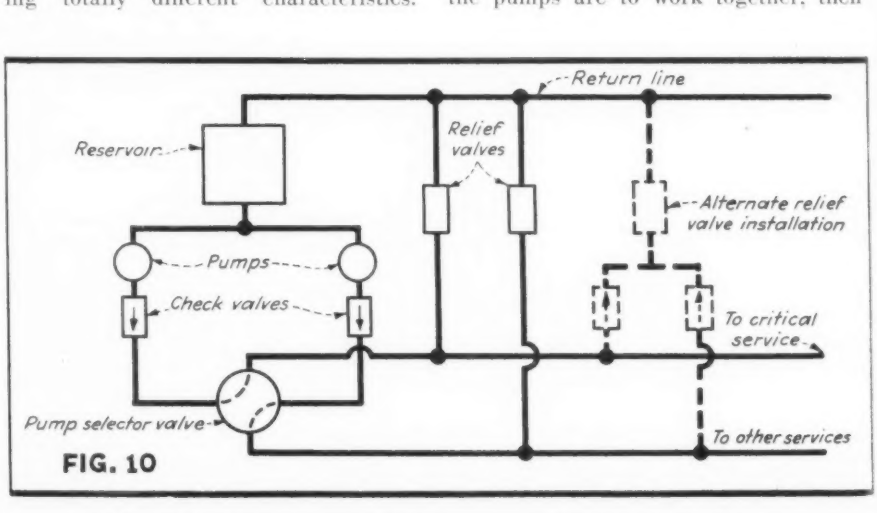


Fig. 10—Arrangement of two pumps when operation has a critical service which must always be kept in operation.

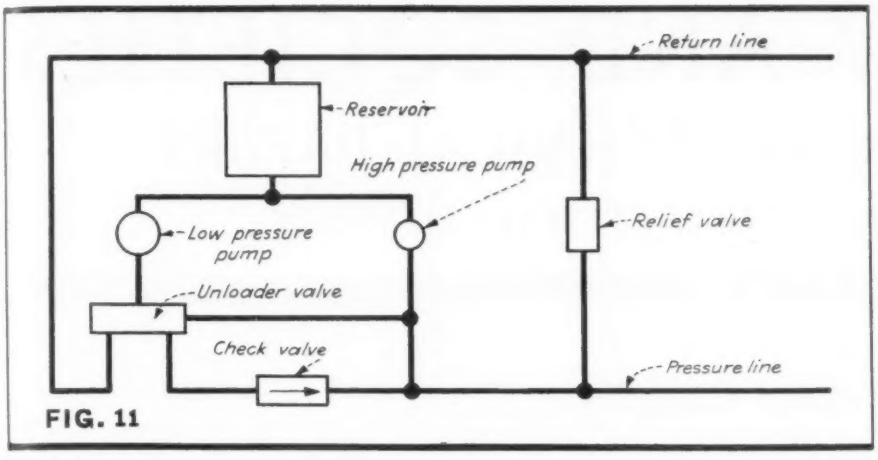


Fig. 11—Pump arrangement used in hydraulic press operation for rapid low pressure closure and to apply high load slowly at high pressure.

some questions must be answered before an intelligent choice of pumps and their connections can be made: Are available units too small so two or more will always have to work together? Are the characteristics of the operations such that large volumes are required part of the time and exactly controlled small volumes the remainder of the time? Does the large volume require as high pressure as the small volume? Is it necessary for one service to continue even when others are not used? Must that service continue even when major breakdowns occur?

If we have a machine which normally operates at full production but must operate economically for long periods at reduced output it may be well to use two pumps to supply the hydraulic services for normal conditions and turn off one pump when the machine is at reduced output. This is one of the simpler problems and is solved as shown in Fig. 9. The pumps are in parallel connection and either or both can be operated. The check valves in the pump output lines prevent backflow through any pump which is not running. If one pump is larger than the other, three steps of output are available: (1) The output of the smaller pump alone. (2) The output of the larger pump alone. (3) The combined output of the two pumps. If a standby pump is required to take care of emergency conditions it could be connected in the same manner.

It is often advisable to connect two pumps, as in Fig. 10, when a machine in which one operation must continue even though other operations are shut down. Here, by proper positioning of the pump selector valve, either pump can operate the critical service while the other operates all other services. Failure of the pump drive or the pump, which operates the criitcal service, requires only that the selector valve be reversed and the other pump will then take over the critical duty although other services will cease.

In hydraulic presses it is convenient to close the press rapidly and then apply the high loads slowly. It is usual to use two pumps both driven by the same motor which should not be larger than necessary. The power system in this case may be arranged as in Fig. 11. Both pumps discharge to the press at low pressure while the press is closing. When resistance is encountered the large-volume low-pressure pump is unloaded to the reservoir and the small high-pressure pump continues to operate the press. When the relief valve setting is reached the output of the small pump returns to the reservoir. It is customary to so valve the press that after holding at pressure for some definite period the press is automatically opened. The use of two pumps in this manner makes it possible to use a small motor because the horsepower involved, under the two conditions of large volume low pressure and small-volume high-pressure, can be nearly constant and at a minimum operating value.

The design of the power system not only involves decisions as to the number and types of pumps, the type of circuit and valves but also as to the locations of the pumps, valves, reservoir and the sizes of lines used to connect them. It is well to compute sizes for the pressure lines with the thought in mind of using the size which will prove more economical. This involves the study of amortized costs of larger lines as compared to the power costs for forcing fluid through smaller but cheaper lines. Another factor which adds to the cost of using small lines is the fact that pump life and valve life are reduced when operated at higher pressures.

The pump inlet lines must also be studied from the cost standpoint. The most common mistake made by the designers of power systems is to make the pump inlet lines too small in diameter. It is well to remember that the total head loss available to force fluid from the reservoir into the pump is usually small. Unless the line is large partial starving of the pump will occur, particularly when full volume discharge is desired. It is usually possible to make the pump inlet line short, and a large diameter inlet is an inexpensive assurance of satisfactory operation.

It is impossible to discuss all of the various combinations of pumps and valves which can be used to build up a power system, and in fact, a list of such combinations would be obsolete within a few days. Every new machine, every new hydraulic unit, and every occurrence of trouble serves to change conditions and our thinking about them. Under these circumstances it was advisable to discuss the basic power systems, to show a few simple combination systems, and leave the thought that the systems can be modified, superimposed, or combined, to give almost any desired characteristics.

Fluorescent Dye Detects Quality of Finishes

ARMY SIGNAL CORPS uses an invisible dye to detect the quality of the "tropicalization," or protective finishing, of its equipment. Requirements for protection of signal equipment in the Pacific are considerably more strict than they were in Europe. The final protective coat, a transparent lacquer through which instructions on the equipment can be read, was hard to inspect for thoroughness and evenness of application. Thus the invisible, or fluorescent dye, is mixed with the lacquer before application. Inspection is then performed under a special lamp which emits strong ultra-violet rays and has a deep purple filter. The lamp picks up the ultra-violet dye in the lacquer and shows how well it has been applied.

In overseas theaters where the lamp is not available, inspectors try to write on the lacquered finish. They look for trouble when they can see anything they have written, for a proper finish makes writing impossible. Use of ultraviolet lamp is preferable, wherever possible.

INDUSTRY AND SOCIETIES

ABSTRACTS of TECHNICAL PAPERS

STANDARDS • READER LETTERS • MEETINGS

Cooperative Wind Tunnel Completed At California Institute of Technology

CREATED through the joint efforts of four aircraft companies, the Southern California Cooperative Wind Tunnel was recently dedicated at the California Institute of Technology. The cost of the tunnel was $2,500,000, of which Consolidated Vultee Aircraft and Douglas Aircraft contributed one-third each and Lockheed Aircraft and North American Aviation contributed one-sixth each. The tunnel, which embodies several new design features, is owned by the cooperating companies and is operated by the California Institute of Technology.

The wind tunnel is a variable pressure, variable density, high speed tunnel with a working section having cross-sectional dimensions of 8½ by 12 feet. Pressure can be varied between ¼ and 4 atmospheres. With 12,000 hp. available to produce the airflow, velocities up to 700 m.p.h. with the tunnel evacuated, and scales equivalent to that of a 40 to 45 foot span model with the tunnel at high pressure, can be attained. In order that the flow over the model be uniform and non-fluctuating, the air is forced through a rapid contraction just upstream of the working section The diameter ahead of the contraction is 31½ feet narrowing rapidly to the 8½ by 12 foot throat at the working section.

Decompression Sphere

A feature not found in other wind tunnels is a steel sphere which surrounds the working section, and permits operating personnel to enter the section without loss of pressure or vacuum in the remaining 90 per cent of the tunnel. The sphere is 31½ feet in diameter, and is closed by a massive steel door 18 feet in diameter and two gate valves which across the airflow circuit ahead and downstream of the working section itself. The gates and main door are raised or lowered by means of hydraulic cylinders. Oil pressure is supplied by a 50 h.p. pump located in the basement. These operations are accomplished at a great saving of time, as compared with other methods of depressurizing the entire tunnel.

Another new feature is a movable steel table which carries models into the sphere on steel rails. Three tables are provided, each of which has a different type of model support and can be rolled into or out of the sphere when the main door is opened. The use of the multiple model table saves hours or even days.

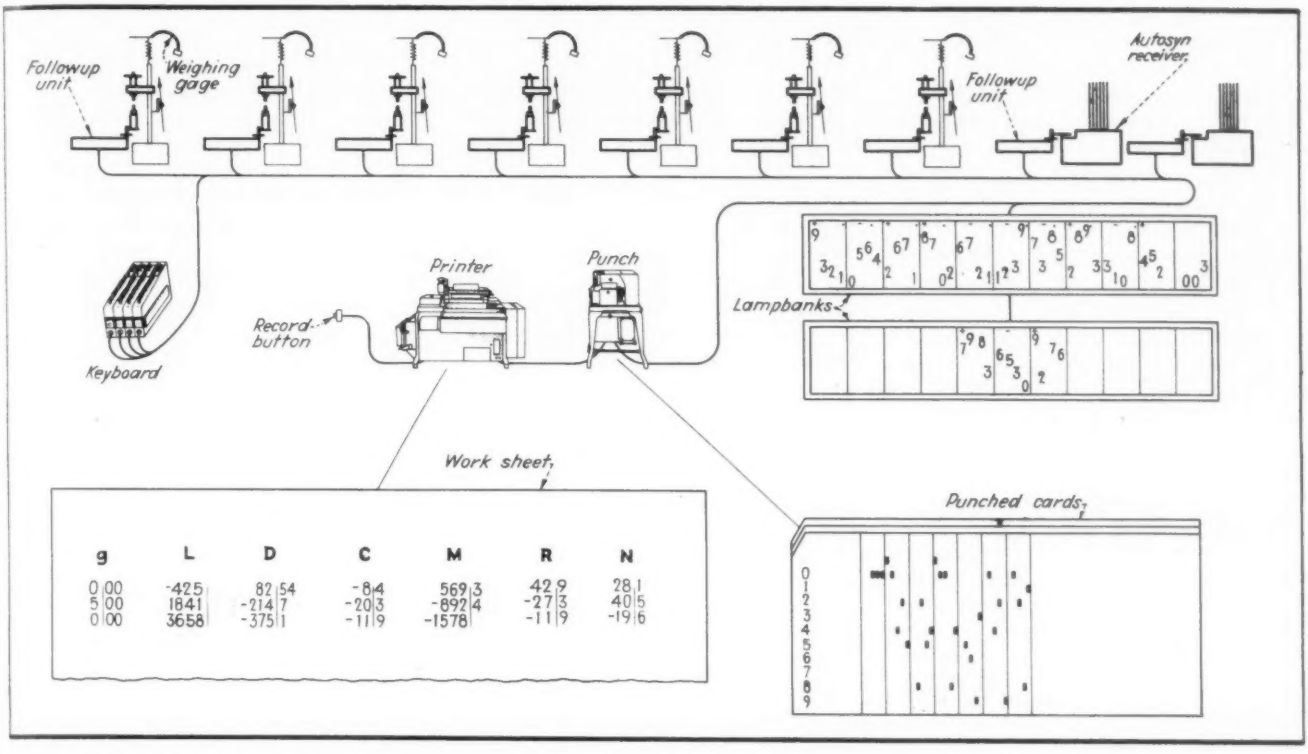
Measuring and Recording

The metrical, or load and moment measuring system, used in the Cooperative Wind Tunnel is unique in several ways. First, it is entirely contained within the structural shell of the tunnel and, therefore, must operate at pressures both above and below normal atmospheric pressure. Secondly, none of the forces or moments arising from the air loads on the model are connected to the measuring devices through normal types of bearings, and thus there are no bearing frictions entering the final readings. Third, all forces and moments are separated so that the six components: Lift, Drag, Cross-Wind Force, Pitching Moment Rolling Moment, and Yawing Moment are made available in the form of direct reading data, without the necessity of additional computations.

This system, which weighs more than 50,000 pounds, floats on thin films of oil and measures forces of the order of a fraction of a pound by means of hydraulic capsules and extremely precise gages. The indicating dials for these gages, as for all other controls, are located in a central control room from which all tunnel operations are directed.

The International Business Machines Corp. developed a system of translating

Master control room of the Southern California Cooperative Wind Tunnel, from which all operations of the tunnel are directed and controlled, and to which all data is transmitted. Forces and movements of the model are indicated on the dials at the right, and on light bank panels, center. Readings are automatically recorded on specially designed I.B.M. machines.


Followup unit
Weighing gage
Autosyn receiver
Followup unit
Printer
Punch
Record button
Keyboard
Lampbanks
Work sheet
Punched cards
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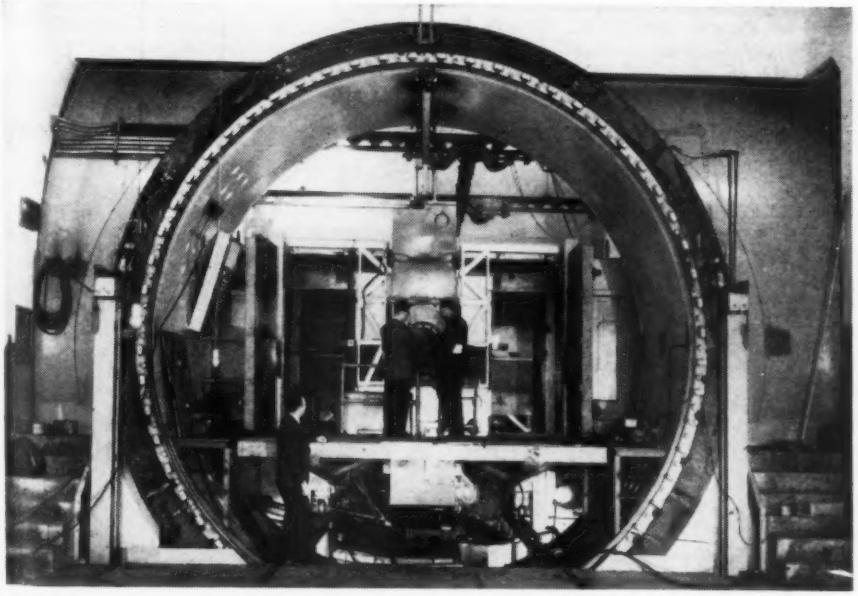
0 00 -425 82 54 -8 4 569 3 42 9 28 1
5 00 1841 -214 7 -20 3 -892 4 -27 3 40 5
0 00 3658 -375 1 -11 9 -1578 -11 9 -19 6

Test data is translated into visual records on light bank panels, printed tapes and punched cards by a system designed and built by International Business Machines Corp. and donated by them to the California Institute of Technology.



Working section in the decompression sphere of the Southern California Cooperative Wind Tunnel. Operating personnel can make adjustments on test models in a few minutes without decompressing the entire tunnel, an operation formerly requiring approximately 8 hours.

the metrical system dial readings into electrical impulses, so that the pertinent data is visually exhibited on light bank display panels and simultaneously recorded on printed tapes and punched cards. This equipment was donated by IBM to the California Institute of Technology, which in turn incorporated it into the Cooperative Wind Tunnel installation. The data on the punched cards are reduced to final form by additional machines.

A dual fan installation, with each fan having sixteen controllable pitch blades, solves the problem of circulating the air through the tunnel and absorbing the full 12,000 hp. available at a given rpm. over a range of air densities of 16 to 1. The downstream fan can be uncoupled and stopped with its blades feathered for high pressure operation when the air is dense and relatively few working blades are required. Just ahead of each fan are adjustable pre-rotation vanes which permit the swirl of air to be controlled by the tunnel operator. All of these adjustments are coupled together so that the entire system may be operated by a set of pushbuttons in the master control room.

Other features include the tunnel cooling radiator, and the system for calibrating model motors.

Bureau of Mines Reports Deposit of New Material

MOUNTAIN LEATHER, a type of asbestos with the scientific name of paligorskite, has been discovered in an Alaskan deposit in quantities sufficient to warrant commercial applications. It is the subject of Information Circular 7313 of the U. S. Bureau of Mines.

This report states that the mineral's unusual characteristics would probably permit it to be readily converted to a pulp in conventional paper-mill beaters, from which many lightweight, acid-resistant and fireproof products could be formed. Wide application of the material in a rough-granulated or processed form for use as an insulating, sound

deadening or shock absorbing medium would still depend on establishing extensive reserves, but specialized applications might be considered on the basis of present disclosures.

The mountain leather, after drying at a low temperature, is light, rather tough, and tears like a piece of heavy cardboard. Upon wetting, the material swells up again, becomes soft and can be torn easily. It is slimy to the touch, and resembles paper pulp. The wet substance is weak enough to suggest that it might be reduced to a smooth pulp in a paper beater. It could then be re-formed into paligorskite paper or cardboard. After removing the color with hydrochloric acid, such a product would have additional applications.

Paligorskite, like asbestos, is an aluminum-magnesium-silicate. The relative proportions are somewhat different; paligorskite is 8 percent Mg O, 14 percent $Al_2 O_3$, 50 percent $Si O_2$, 3 percent $Fe_2 O_3$ and 3 percent Ca O, while free and combined water total 18 percent.

Patents for Licensing Listed by Patent Office

A NEW SERVICE to industry and inventors was put in operation on June 1 by the United States Patent Office. The purpose of the service is to bring to the attention of interested persons patented inventions under which the owners are willing to grant licenses. It is hoped that such information will lead to greater employment opportunities in the reconversion period, as well as permit industry to become acquainted with what is being done in various fields. To this end, a Register of Patents Available for Licensing is being established, and will be maintained in the Patent Office. This register will be open to public inspection in Washington, D. C. In addition, lists of such patents will be published in the Official Gazette of the Patent Office.

National Instrument Society Formed

A NATIONAL SOCIETY to be known as "The Instrument Society of America" was organized in Pittsburgh on April 28 at a conference attended by delegates from 15 measurement and control instrument societies that have been growing in different industrial centers throughout the country. The purpose of the society will be to advance the arts and sciences that are connected with the theory, design, manufacture and use of instruments. The society is non-professional, and offers membership to any person, firm or institution interested in the objectives of the society. Pro-tem officers were elected as follows: President—A. F. Sperry, Chicago; Vice President—C. F. Kayan, New York; Treasurer—C. E. Fry, Pittsburgh; Secretary—Richard Rimbach, Pittsburgh. The office of the secretary is the temporary office of the Society, located at 1117 Wolfendale St., Pittsburgh 12, Pa.

Navy Organizes Office of Technical Research

THE NAVY DEPARTMENT moved recently to implement the high regard for scientific research and development to which a number of its ranking officers testified earlier this year before the Woodrum Committee on Postwar Military Policy. The activities of this committee are discussed in an article on page 433 in this issue of PRODUCT ENGINEERING.

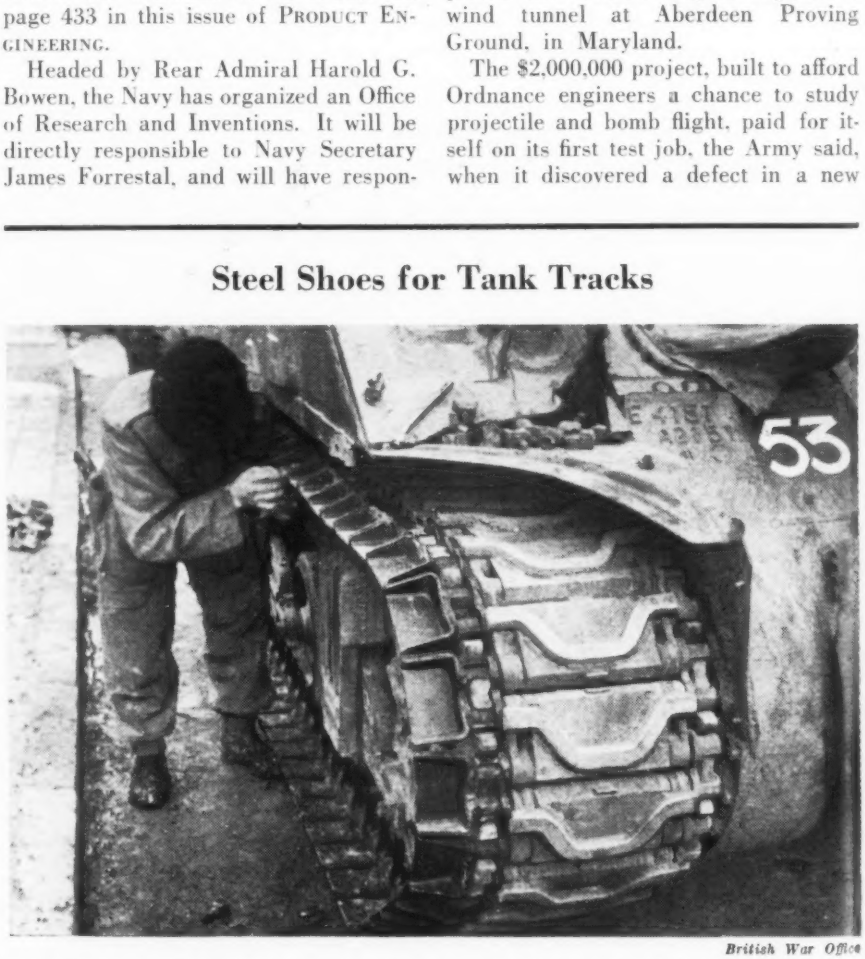
Headed by Rear Admiral Harold G. Bowen, the Navy has organized an Office of Research and Inventions. It will be directly responsible to Navy Secretary James Forrestal, and will have responsibility for Navy research. Into the new agency were merged the Naval Research Laboratory, the special devices division of the Bureau of Aeronautics, the Office of Research and Development and the Office of Patents and Inventions. Admiral Bowen headed the latter before establishment of the new office. Assistant to him will be Capt. Luis deFlorez, who headed the special devices division of the Bureau of Aeronautics. Capt. de Florez won the Collier Trophy last year for his development of devices for training naval aviators. Adm. Bowen was closely associated with the development of radar, high-pressure and high-temperature steam propulsion equipment and numerous other developments. developments.

Army Completes Largest Supersonic Wind Tunnel

ARMY ORDNANCE stole a page from the Air Forces' book recently when it completed the world's largest supersonic wind tunnel at Aberdeen Proving Ground, in Maryland.

The $2,000,000 project, built to afford Ordnance engineers a chance to study projectile and bomb flight, paid for itself on its first test job, the Army said, when it discovered a defect in a new

Steel Shoes for Tank Tracks



British War Office

To give a better grip on soft muddy ground, the tracks of British tanks were widened by adding a steel shoe to each link. With the shoes, the track has an additional width of six inches, preventing the tank from bogging down. The photograph shows a British tankman fitting the shoes to the tracks.

RECENTLY ELECTED SOCIETY OFFICERS

Society of the Plastic Industry, 295 Madison Ave., New York, N. Y. President—Neil O. Broderson, Rochester Button Co.; Vice President—George H. Clark, Formica Insulation Co.; Secretary-Treasurer—Warren E. Hill, Prolon Plastics Div., Pro-phy-lac-tic Brush Co.

American Society of Mechanical Engineers, Metropolitan Section, 29 W. 39th St., New York, N. Y. Executive Committee: Chairman—A. Ehbrecht, Gries Reproducer Corp.; Secretary—E. Douglas Grimison, Babcock & Wilcox Co.; Treasurer—R. W. Flynn, Gulf Oil Corp.

American Gear Manufacturers Association, Pittsburgh 22, Pa. President—Paul W. Christensen, Cincinnati Gear Co.; Vice President—Thomas J. Bannan, Western Gear Works; Treasurer—Raymond B. Tripp, Ohio Forge & Machine Corp.

American Society for Metals, New York Chapter, 40 Wall St., New York, N. Y. Chairman—George K. Herzog., Electro Metallurgical Co.; Vice Chairman—Raymond F. Vines, Ford Instrument Co.; Treasurer—Henry C. Bostwick, Westinghouse Electric Corp.; Secretary—Hanson S. Lewis, International Nickel Co.

American Institute of Electrical Engineers, 33 W. 39th St., New York, N. Y. President—W. E. Wickenden, Case School of Applied Science.

bomb about ready to go into mass production. The bomb tunnel is designed to allow speeds of 1.7 times the speed of sound, and the projectile tunnel to produce speeds of about 3,000 ft. per sec.

Safety Color Code Proposed by ASA

THE SAFETY COLOR CODE proposed as a national standard by the American Standards Association grew out of a standard code adopted by the Army Service Forces and its Quartermaster Corps. Proposed in April, 1944, to meet the Army's need for such a color code, the system uses five colors—red, green, yellow, white and black—and combinations thereof. Red is used for fire protection equipment and danger and stop signals. Green is the basic safety color, designating first aid equipment and safety devices. Yellow is for caution and to denote hazards. Black, white or a combination of the two is used for housekeeping, sanitation and traffic markings, with care being taken not to conflict with existing signals standard in sea and air navigation, and rail transportation. ASA set up the proposed standard code and will circulate it among safety engineers and other interested organizations, seeking suggestions and comment.

House Approves Bill For Military Research

THE HOUSE MILITARY AFFAIRS COMMITTEE has reported favorably a bill authorizing the appropriation of not more than $8,000,000 yearly to the National Academy of Sciences to finance military research and development projects endorsed by the Research Board for National Security.

The bill provides that all experiments or other projects be carried out pursuant to contracts or other arrangements by the Academy with "individuals, educational and scientific institutions, industrial organizations and other public and private agencies determined by the board to be appropopriate." This provision guards against the expenditure of funds to provide research facilities operated by the Research Board or by the Academy. In addition, it requires semi-annual reports on expenditures to the appropriations committees of the House and Senate.

The committee report noted that the bill "provides the means for a permanent program of scientific research in the interests of national security."

"The problem of a permanent program of scientific research has been considered by the select committee on post-war military policy, and by the Army and Navy, as well as by the committee on military affairs in connection with the bill herewith reported," the report declared, "and all are agreed that a permanent program is essential in the interests of national security and that the best method of providing for such a program is the method prescribed in the bill."

Abstracts of Technical Papers

Spot Welding Aluminum

From "Aircraft Spot Welding At Willow Run" by H. A. Mullen and L. Boelter. Presented May 1, 1945, Buffalo Section, Society of Automotive Engineers.

Since the B-24 bomber was first made at Willow Run 100 assemblies have been converted from riveting to spot welding. This represents 60,000 spot welds, which saved 125 man-hours per airplane, reduced weight, and cut the original cost in half.

A part of the procedure in converting to welding was to determine the most desirable weld patterns, which involved numerous tests of shear strength, fatigue strength, corrosion, and metallographic studies. Results were correlated with welding and physical tests and surface resistance measurements.

Specialized surface preparation was found to be essential in maintaining consistant quality in spot welding. The most satisfactory cleaning process is done in five steps: First, cleaning by means of a solution consisting of 3.33 oz. per gallon of sodium meta-silicate, $\frac{2}{3}$ oz. per gallon of borax, and $\frac{1}{4}$ oz. per gallon of a wetting agent (Naccanol NR). Temperature is 185 to 210 deg. F. Cleaning takes 1 to 5 min. After rinsing in cold water the parts are etched to replace the oxide with another oxide that gives a consistant fusable surface. The etching bath consists of 1 gal. sulphuric acid (sp. g. 1.84), 3.5 lb. chromic acid, and water to make 10 gal. of solution. Temperature is kept at 175 to 180 deg. F. Etching takes 3 to 5 min. The part is rinsed again in cold running water and dried quickly by means of hot air.

Tests of prepared surfaces showed that it was impossible to obtain an oxide-free aluminum surface by chemical means. Of the nine known oxides of aluminum, at least one is conductive to good spot welding. The desirable anhydrous oxide surface produced by this process has a more uniform surface resistance than any other oxide. Although amorphous surface oxide regrowth starts immediately after mechanical or chemical cleaning, the rate is so slow that test pieces were found to be weldable 3 to 5 days after treat-

ment, assuming no excessively dirty atmosphere or handling. The undesirable oxide re-appears 15 min. after cleaning with other solutions.

Experience with 121 late model welding machines of various types showed that there is no perfect all-around machine and each machine is used for its best purpose. Some machines are slow but produce fine consistent quality while others are fast but erratic. Some are excellent mechanically but may have a high power demand and give panel trouble while others, seemingly perfect electrically, have frequent mechanical disturbances. Some machines are good on heavy gage material and others best for light gage sheet.

Electrical Insulation Failures

From "Chemical Contamination as Causes of Electrical Insulation Failures" by C. H. Braithwaite, Jr., and Graham L. Moses, Westinghouse Electric Corp. Presented March 1945, American Institute of Electrical Engineers.

Certain insulation failures have been traced to chemical contamination with ionizable materials, particularly certain types of hand creams, soldering fluxes, and germicides for lubricants. Contaminants may be introduced during otherwise insignificant manufacturing steps, during repair or while in service. They may be of a type that is harmless when dry and at room temperatures, but which become conducting when humidity is high, particularly when hot. The contaminant may cause metallic corrosion, which produces electrolytes, thus tending to accelerate failure.

Soldering fluxes containing zinc chloride or ammonium in any form or manner have caused failure either during manufacture or later in service. They have been shown to reduce greatly the electrical resistance of mica, cotton, and asbestos insulating materials under humid conditions. Rosin in alcohol has been found to be relatively safe, since electrolytes are deposited.

Of the hand creams, the vanishing cream type having soap bases are most troublesome. They become conducting at higher humidities and lower insulation resistance. Permissible types should be limited to those leaving a thin film of resin or wax on the hands, but which are neutral in reaction and not detrimental to insulation in normal use. Each hand cream should be investigated, before being accepted.

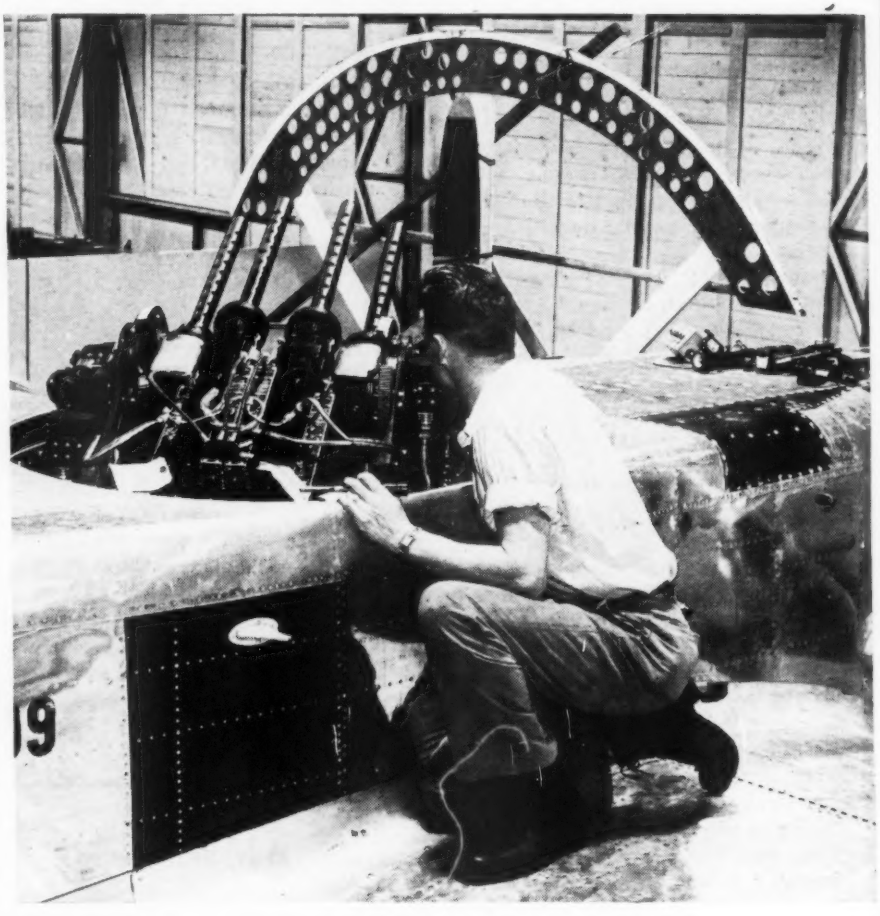
Germicide contamination sufficient to cause failure resulted from the addition of as little as 0.4 percent of a phenolic material in lubricant for blocks used in pressing armature coils.

Contaminants are introduced in other ways also. Failures in chemical plants have resulted from contact with different materials. Scrappings from the windings of a motor used in a magnesium plant, for example, contained magnesium chloride and other hygroscopic salts. While this contaminant did not deteriorate the varnish, it formed a conducting path through cracks in the film and around the leads.

A casein adhesive used to bond asbestos insulation to wire caused failures because a change in formulation had introduced sodium carbonate and sodium phosphate, which are electrolytes. As a result an organic type of synthetic adhesive replaced the casein adhesive in manufacture.

Failures have also been traced to fire

Fire Interrupter Protects Propellers



Chewing off of propellers and rudders by fire from the remote control gun turret of the Black Widow is prevented by this fire interrupter, developed by Northrop Aircraft, Inc. To do this, the armament men first line up the turret guns for a dead-ahead position. The fire interrupter boards are then placed in position. These are wooden frames which surround the area which the four machine guns must cut out. The boards are painted white on the edge farthest from the cutout area, while the remainder is painted red. Holes in the boards are for the purpose of reducing the weight of the structure. Next, the guns are set to skip these areas. A sighting instrument is inserted in the barrel of one of the guns, and the turret is swung around until the white edge of the fire interrupter board is visible. When none of the red area can be seen through the sight, the worker adjusts a cam rod within the turret—so that whenever the turret swings to that position, the cam will actuate a switch which causes the gun to cease firing. When the white edge on the other side of the protected area is visible, the turret rides over the cam, the cutoff switch snaps back, and the gun resumes firing.

extinguishing chemicals, particularly those produced by mixing sodium carbonate and an inorganic acid. These cannot be removed by filtration methods from varnish contained in tanks.

Aircraft Current-Limiting Fuse

From "A Current-Limiting Fuse for Aircraft Applications" by A. H. Powell, General Electric Company. Released for abstracting July 1, 1945 by the American Institute of Electrical Engineers.

The increasing number of operations being performed electrically in aircraft has required the development of accurate, consistent and correct fuse operation. For several years, a current-limiting fuse, had been available for central station and industrial users. This fuse consisted of a pure silver wire element in an interrupting medium of granular quartz.

The author describes in detail the fuse units, fuse supports and electrical and vibration tests. Suggestions are made as to the correct application of these current-limiting fuses in aircraft installations. This type of fuse will dependably interrupt more than 4,000 amp. at 120 volts, 400-cycles, single phase a. c., or at 120 volts d. c., with an arcing time of less than ¼ cycle on the a. c. circuit.

Discussions and Comments From Readers

SIMPLIFIED FILING SYSTEM URGED BY READER

To the Editor:

Most engineers have the good habit of hoarding information in the form of catalogs, manuals, reports, articles from trade journals, and, occasionally, records of past personal accomplishments. While experienced engineers appreciate the value of a well indexed file, most of us do not take the time to maintain anything but a pile. Those who protest that they do not have time to maintain a filing system are wasting time in going through the burial ceremony of adding further data to the stock pile.

Anyone can establish and maintain an efficient filing system with very little effort. The first step should be the preparation of a list of group headings. These should be selected to suit the particular need. The writer uses the following:

Bearings; Bibliography; Castings; Drafting; Fasteners; Fits & Tolerances; Forgings; Gears & Splines; Geometry & Mathematics; Inspection; Machining; Materials; Miscellaneous; Organizational; Processes; Screw Threads; Springs; Structures.

Two headings in this list are of general interest. "Bibliography" is for those items which can not be obtained for the file, but are available from other sources if the need should arise. It consists of a list of references arranged by groups similar to the file headings. The other heading is the inevitable "Miscellaneous" of filing systems, which in this case includes information in fields of endeavor from which only a few scattered items are collected.

The next step requires an evening of valuable but well spent time for the average collector. All of the data on hand should be segregated according to the predetermined headings. It is recommended that, in case of doubt, more headings be used than the apparent minimum. If a change is desired after the system is in operation, it will be relatively easy to combine two or more groups. At this point, considerable self control must be exercised so that all of the material is classified before taking up any single interesting item for detailed study.

So far we have succeeded only in making several smaller piles out of one big pile. The final step is the most important one and creates what most private files lack; a cross index. Cross indexes are generally cumbersome things created to delight a bookkeeper's heart. This one is surprisingly easy to establish and maintain. Each group should be leafed through, and if any items are found which may be of interest in connection with another group, a suitable reference is made on an 8½ x 11 sheet which is then added to the other group. Thus, it does not greatly matter in what group any doubtful item is filed, because reference sheets will be included in all applicable groups. This method also solves the problem of what to do about those clippings which have useful material on both sides of the page.

The cross indexing can be accomplished a little at a time; say, one or two groups per evening. An important benefit resulting from the leisurely review of collected data is the rediscovery of highly prized, but rarely used information. Also, much obsolete material can be discarded at this time.

It may be found convenient to place each group within a folder or an expanding type envelope. How the file is kept is not important; how it is organized is all-important, for it is only with an effective system that one can dispense with the usual "I wish I could remember where I saw that."

—J. T. Bennett
Production Design Engineer, North American Aviation, Inc.

FURTHER DISCUSSION OF NOISE CONTROL

To the Editor:

In the March 1945 issue of Product Engineering, I read with considerable interest Wm. A. Keetch's article on "Noise and Its Elimination." I found this to be an excellent discussion on the subject, but would like to point out that on page 184, Mr. Keetch has over-simplified the problem by stating,

"A gear train composed of one fiber and one steel gear are less noisy than two steel gears running together."

This is true only in most cases where the noise can be attributed to the natural frequency of the steel gear which is replaced by the fiber gear. Usually it has been our experience that gear noise is traceable to the frequency of the meshing gear teeth or to a cyclic error in the machine on which the gears are produced. In these cases, we have found that very little reduction in noise can be expected in changing from steel to bronze or to a non-metallic material. I am curious to know whether or not Mr. Keetch's experience in this problem agrees with mine. —J. T. Maddock
Joshua Hendy Iron Works

To the Editor:

Mr. Maddock's comments on my article were most gratifying. With regard to his thoughts on the use of fiber or non-metallic gears, I agree that their greatest advantage, from the point of view of sound reduction, is obtained where the noise of a steel gear may be attributed to its natural frequency. This, of course, is the case where the natural frequency is at or near the tooth frequency or an harmonic thereof. Considerable gear "ringing", however, is often a result of impact caused, for example, by an imperfect or damaged tooth or by intermittent loading. In such instances, the damping and cushioning effect of the non-metallic gear material is advantageous.

—W. A. Keetch
Lord Mfg. Company

New Books

German-English Dictionary of Metallurgy

T.E.R. Singer. 298 pages, 5¼ x 7¼ *in., blue clothboard covers. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York,* 18, *N. Y. Price* $4.

Intended for technical people using literature in the fields of metallurgy, metallography, mining, mineralogy, crystallography and the working of metals, this dictionary includes material in those related subjects as well as metallurgy. Special consideration has been given to the modern German tendency to eliminate from the German language technical words of non-German origin. In these cases, the author follows the more familiar German usage with the modern word. Obsolete terms, such that are found in old patents, have also been included. The author was formerly in charge of the chemistry reading room at the New York Public Library.

Airframe Materials

F. S. Stewart. 237 *pages,* 5¼ x 8¼ *in., blue clothboard covers. Published by McGraw-Hill Co., 330 W. 42nd St., New York* 18, *N. Y. Price* $2.50.

This is a book on composition and strength of materials as applied to aircraft structures. In addition to the materials themselves, the author discusses the effect of various factory operations and of aging on those materials. The early chapters are devoted to the common concepts of chemical and physical properties of materials, including methods of testing mechanical properties. A discussion of the heat treatment of aluminum alloys, steel and magnesium follows. Other metal working processes, such as casting and forging, are covered. Finally, there are chapters on wood, veneers, plywood, adhesives and plastics. The text is well illustrated and should serve as an introduction to aeronautics.

High Speed Combustion Engines

P. M. Heldt. 776 *pages,* 5¼ x 8¼ *in., red clothboard covers. Published by P. M. Heldt, Nyack, N. Y. Price* $7.50.

For the twelfth edition of this well-known text and reference work, the author made a complete revision. Considerable new material was added, particularly on the subjects of engine blocks, connecting rods, crankshafts, flywheels, valve-actuating mechanisms, water and air cooling, manifolds and mufflers, and engine tests.

The first edition appeared in 1912 under the title, "The Gasoline Motor." From the beginning the work was intended to serve both as a textbook for students and a reference for engineers. It gives a thorough explanation of engine design and all related problems. In addition to the subjects given above there are chapters on balancing of engines, combustion chamber design, engine mountings, pistons, bearing loads, vibration problems, valves, carburetors, ignition equipment, and other subjects. Most of the many illustrations are line drawings showing the internal cross sections of engines and graphic data.

Plastics in Practice

John Sasso and Michael A. Brown. 185 *pages,* 7¾ x 10¾ *in., maroon clothboard covers. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York* 18, *N. Y. Price* $4.

As a handbook of plastics product applications, this book fills a specific need. Unlike general works on plastics, which give chemical composition and methods of fabricating for each of the plastic materials, this volume presents to the design engineer or executive a list of "case studies" of plastic articles whose economic and industrial worth have been proven. The volume is arranged to provide information on plastic materials and processes by means of specific applications. A brief introductory section gives a general review of plastic materials and processes, to be used as a reference guide for the discussion of applications.

Mathematics Dictionary

Glenn James and Robert C. James. *Revised Edition,* 319 *pages,* 6 x 9 *in., blue clothboard covers. Published by The Digest Press, Van Nuys, Calif. Price* $3.

In revising the first edition of this dictionary the chief changes that have been made are the addition of many new terms, the introduction of more working examples, the simplification of definitions, the addition of irregular plurals, the correction of typographical errors, the substitution of five place logarithm tables for four place, and the addition of extensive integral tables.

One phase recognized in the first edition and emphasized in this revision is the simplification of elementary concepts in the interest of students and laymen.

The dictionary is designed primarily to provide a condensed source of facts and principles for men in all fields of industry and science who have occasion to use mathematics.

Bulletins

Helical and Spiral Springs

S. A. E. Special Publications Dept., 29 West 39th St., New York 18, *N. Y. Copies are available to S. A. E. members at 50 cents each, to non-members at* $1 *each.*

"Manual on Design and Application of Helical and Spiral Springs for Ordnance", written at the request of the U. S. Army Ordnance Department by the Spring Committee of the S. A. E.—War Engineering Board under the chairmanship of J. C. Zeder, Chrysler Corporation, and Tore Franzen, Chrysler Corporation. The committee consists of 31 members representing major vehicle, parts, and spring manufacturers, and ordnance experts.

The manual covers fundamental considerations, important design factors, spring materials and maximum design stresses, general spring tolerances, spring design formulas, references on material specifications, and specification for alloy spring wire.

Data and recommendations contained in the manual represent the coordinated views of fabricators and users of springs and spring materials.

Fabricating Methods for Lumarith, Celluloid and Similar Thermoplastic Materials

Celanese Plastics Corp., 180 *Madison Ave., New York* 16, *N. Y.* 136 *pages. Price* $1.

Many of the fabricating methods discussed are also applicable to methyl methacrylate and other non-cellulosic thermoplastics. Cutting and machining processes are described in detail: blanking, sawing, routing, drilling, reaming, tapping and lathe and screw machine operations. Data is given on drill and saw speeds, and types of tools and blades necessary for each operation and each material. In addition there are chapters on fabrication of film stock, finishing operations and molding processes. The text is profusely illustrated with photographs and line drawings.

STEADY JOBS *and* EQUIPMENT BUYING

SUSTAINED employment is not an attainable goal unless we can moderate the erratic fluctuations which have characterized the markets for producers' equipment in past periods.

In the 35th editorial of this series, "Sustained Construction Activity", it was pointed out that there is no specific that can cure our economy of its "boom-or-bust" proclivities. Rejecting the notion that the construction industry could be so managed as to stabilize business as a whole, that editorial stressed the important contribution it could make to that end, and suggested several practical expedients through which construction activity might be regularized.

Producers' equipment represents an area of production quite as broad and diverse as construction, though smaller in aggregate value. The classification embraces all types of durable equipment bought and used for profit—locomotives, motor trucks, electric generators, conveyors, machine tools, farm implements, and so on down to surgical instruments and dentists' drills.

Although the output of such equipment averages over a long period only 5 or 6 per cent of the nation's total output, it resembles construction in its extraordinary ups and downs. While its component items differ widely in the amplitude and violence of their fluctuations, the class as a whole is one of the most unstable sectors of the economy, making therefore a quite disproportionate contribution to the cyclical swings of total production and employment. From 1929 to 1932, for example, the decline in the output of producers' equipment (at constant prices) was 65-70 per cent, in contrast to a decline of 25-30 per cent in the national output exclusive of such equipment and construction.

A more recent example of the volatility of demand in this field may be found in the movement of a monthly index of orders for industrial equipment, which rose from 92 in the spring of 1936 to 160 in the spring of 1937, falling thence to 65 in the summer of 1938 and rising again to 142 in the fall of 1939. Such fantastic oscillations present an obvious and inescapable challenge to all concerned with economic stabilization.

Not only are these fluctuations bad for the economy; they represent demonstrably bad buying policy on the part of the purchasers of equipment. Peaks in demand come characteristically just before a business depression (1919, 1929, and 1937, for example) when machinery costs the most to buy and install and when it has the lowest expectancy of continuous use. At exactly the wrong moment everyone wants to buy. In the depression itself, on the other hand, with costs down, and with nowhere for the economy to go but up, equipment is a drug on the market. No one wants it when it is cheap and has the greatest prospect for steady employment. Here is a behavior pattern so profoundly irrational there must be hope for its correction.

There is an inveterate tendency for business management to forecast the future simply by projecting the trends of immediate past. Although it is axiomatic that the chance for an extended period of further prosperity is inversely related to the duration of the prosperity already experienced, this truism is generally ignored. The longer the boom has run, the more certain is business management that it will continue indefinitely. Convinced at last by "actual experience" that prosperity is here to stay, executives give the green light to commitments for expansion and modernization previously deferred in a skeptical attitude of "wait and see". The result, so often repeated in our economic history, is an explosive burst of demand for equipment coincident with, and contributing to, the final spasm of a boom. Witness the phenomenal rise in industrial equipment orders during 1928 and the spring of 1929.

The same prophetic illusion works in reverse during a depression. Recent experience is projected into the future. Although the mathematical probability of an imminent and prolonged period of prosperity increases directly with the duration of a depression, it finds little reflection in business decisions. Timidity and caution are the order of the day.

Compounding the errors caused by faulty perspective, are a number of influences which make it extremely difficult for individual enterprises to follow a policy geared to sensible long-term considerations. In a boom, particularly in its climactic phase, most producers find their order books crowded beyond the potential of their current capacities and are faced with the alternatives of expanding or losing trade to competitors. In depression the situation is reversed, and producers with unused facilities find it difficult to justify increases in their capital charges.

An even more controlling factor in many cases is the availability of funds. This is especially important

for small concerns. Typically such firms enjoy but limited credit, and with no ready access to the securities markets, their capital expenditures depend primarily on earnings. When they are making money, they can afford to buy equipment; when they are losing, they largely disappear from the equipment market. Even great enterprises, though less dependent on earnings as a source of capital financing, are profoundly influenced by the volume of internal funds available for the purpose, a volume as a rule far greater in prosperity than in depression. Moreover, it is usually easier in good times to obtain outside funds through the sale of stock or by borrowing, since in bad times bankers, underwriters, and investors are susceptible to the same timidity and caution that afflict business management generally.

We are dealing here with a combination of psychological, physical, and financial forces which conspire to aggravate the instability of demand for capital equipment. What can be done to reduce this instability and thus to bring equipment purchasing into a more sensible and constructive pattern?

There is no panacea, no royal road to the solution. The problem has been with us since the beginning of the industrial economy. It is complex and difficult. It is not, however, wholly intractable. We may reasonably hope that industry will, through intelligent effort, make substantial progress toward a satisfactory solution. The industrial equipment field is one in which government, except for war periods, has exerted little direct control. The best insurance against the institution of government measures is to so conduct activities in the equipment field that no justification for government interposition can be made.

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1. The first and most important step is for industry itself to reconsider its heretofore haphazard and opportunistic policy in the purchase of equipment, substituting so far as possible a regularized, long-range programming of expenditure that will resist both the excited long-buying of booms and the equally disturbing underbuying of depressions. Such long-range programming is particularly appropriate and advantageous for large enterprises in established industries such as railroads, electric power, steel, automobiles, and the like, but it makes sense much more generally.

Once executives come to realize that a reasonably stable equipment program contributes not only to the welfare of the economy but also to the lowering of their long-run equipment costs, the opportunity to combine a public service with private advantage should induce them to recast their policies accordingly.

There is an even more compelling reason for purchasers of industrial equipment to do everything possible to regularize their demands. Some concerns unquestionably will find themselves in a postwar position where speedy delivery of needed equipment, even though it involves the payment of premium prices, will seem to be justified. But there is no system of accounting that can show it to be a profitable transaction to promote an equipment industry boom that runs a brief course only to collapse when the backlog of deferred maintenance and development has been satisfied. That, historically, has been the trigger which trips the door to the depression phase of the business cycle. No immediate advantage can compensate for the contagious paralysis that infects all business enterprise when major layoffs occur in any major segment. No precautionary measures, self-imposed by business, can be regarded as unduly severe if they can prevent this devastating blight.

2. Financial agencies can and should play a responsible role in regularizing equipment demand. Funds for the purchase of producers' equipment should be offered boldly and at low interest during depression periods, and should progressively tighten as a boom market bids up the price of purchase and installation. Banks and financial houses have excellent facilities for gathering and interpreting market and general economic information. It is good business for them, and for the national economy, to exercise their accepted discretions in a manner that will help to promote economic stability.

3. There now is almost universal recognition of the need for a thorough-going revision of our corporate tax structure to the end that effective incentives may be offered for private capital investment. The possibility of including provisions which would offer special tax concessions to equipment investments made in depression periods is worthy of intensive exploration.

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The fundamental problem here is educational. If all business enterprises in a position to do so were to regularize their equipment expenditures, it would have a tremendously beneficial effect. True, it would accomplish no miracles. For many concerns it is not feasible to schedule equipment buying over a long period. Even those who do schedule it are likely in practice to attain only a relative stability. It must be acknowledged, moreover, that few programs could withstand indefinitely a very deep and prolonged depression such as we had in the thirties. Nevertheless the adoption of stabilization policies where feasible would make a signal contribution both to the restraint of booms and to the mitigation of depressions. Here is something industry can do for itself.

It is easy to disparage such remedies for economic instability as are here proposed on the ground that they are partial only. However, joined with others also partial, they can achieve in combination a solid progress toward the goal of sustained high level employment—progress that is unattainable through economic cure-alls. The road suggested is a slow road and difficult, but it leads upward.

President, McGraw-Hill Publishing Co., Inc.

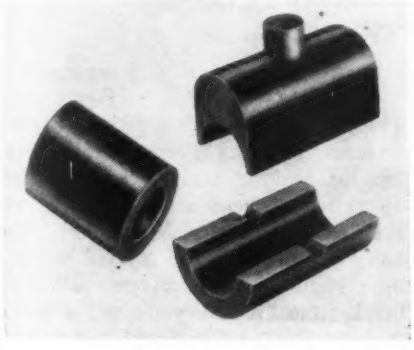
THIS IS THE 37TH OF A SERIES

NEW MATERIALS AND PARTS

Self-Lubricating Bearings

Morganite Brush Co., Inc., Long Island City 1, N. Y.

These bearings are available in compositions of carbon, graphite or both. Bearings of these materials are self-lubricating and immune to acids, alkali and most solvents. They have low coefficients of friction and expansion. They impart no odor or taste to liquids, hence are suitable for use in chemical and food processing industries. The bearings are readily machinable but can be molded with tolerances to 0.001 inch. They can be supplied in any shape—complex sleeve or slit types. They may be plated, take molded-in fastenings and can be shrunk, press fitted, or vulcanized to rubber. Operating speeds are claimed to 50,000 r.p.m. with thrust loads to 30 lb. per sq. in. on loads to 2,000 lb. per sq. in. at lower speeds. Their resistance to high temperatures (to 850 deg. F.) has resulted in use in steam turbines, drum dryers, and paper mills.



Hermetically Sealed Instruments

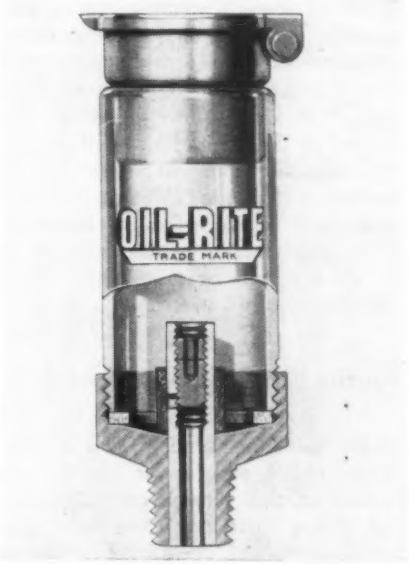
Hickok Electrical Instrument Co., 10544 Dupont Ave., Cleveland 8, Ohio.

Hermetically sealed electrical indicating instruments with internal pivot construction are announced in 2½ in., 3½ in. and 4 in. round styles. Dimensions are in accordance with American War Standards Assn. drawings C39.2-1 and C39.2-2. The 4 in. round instruments are for use in radio service equipment where several scale arcs are required and have a body diameter of 3½ in., flange diameter of 4½ in., taking a mounting hole radius 1 15/16 in. These instruments include voltmeters, ammeters, milliammeters, and microammeters, both a.c. and d.c. as listed in American War Standards specifications C39.2-. All sizes are housed in metal cases, hermetically sealed by a clamping mechanism. The glass withstands 25 lb. pressure per sq. inch.

Adjustable Feed Oiler

Oil-Rite Corp., 3482 S. 13th St., Milwaukee 7, Wis.

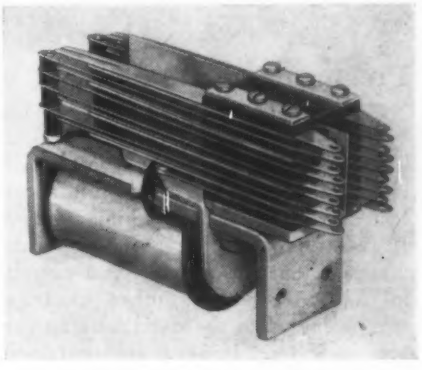
Gravity feed oiler for heavy duty applications wherever an adjustable drop oiler of small capacity feeding filtered oil is needed. It is suitable for very slow or medium feeds or continuous operating machines. To adjust the oil flow, hinge lid is held open and a standard hexagonal key is placed through the hollow lock screw into the set screw and adjusted to suit. The base is made of brass and the reservoir is of transparent plastic. The visible oil supply indicates when a refill is needed. It is available in four body sizes. Standard capacities are 1/8, 1/4, 1/2 and 1 ounce having 1/8 in. or 1/4 in. pipe thread.



Multi-Contact Relay

R-B-M Mfg. Div. of Essex Wire Corp. Logansport, Ind.

This long coil type 20000 relay is applicable to electronic and communication uses, where minimum operating currents are important factors. Contact spring assemblies of this relay can be furnished in one, two, or three stacks—with various combinations, according to circuit requirements, up to 16 springs. Coils are available in voltage ranges from 1 1/2 to 28 volts d.c. This type of relay is also available in two-pole double-throw contact arrangement, with current sensitive coil operating at 3.2 milliamps. pickup and 1 to 1.5 milliamp. dropout. They are produced in two sizes; standard—4 3/4 in. long, 1 in. wide, and approximately 1 3/4 in. to 2 1/2 in. high; intermediate—3 5/8 in. long, 1 in. wide, and 1 3/4 in. to 2 1/2 in. high.



Miniature Instruments

Dept. S, MB Mfg. Co., Instrument Div., 250 Dodge Ave., East Haven 12, Conn.

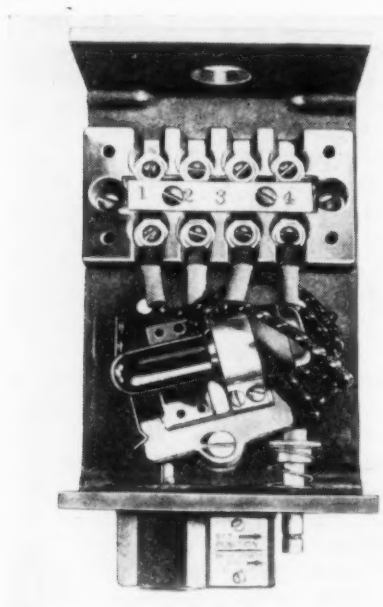
Miniature voltmeters, ammeters, milliammeters and microammeters measuring but one inch in diameter and weighing only 1¼ ounces have been developed. These moving coil type instruments are hermetically sealed in an

anodized aluminum case which also has provison for hermetically sealing the instrument case to the mounting panel. As a companion instrument, a 1½ in. round hermetically sealed meter of the same type case construction, weighing 1½ ounces, has also been announced.

Pressure Switch

Walter Kidde & Co., 140 Cedar St., New York 6, N. Y.

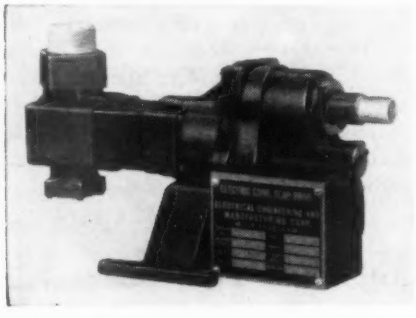
The pressure switch is an accessory device designed for use with built-in carbon dioxide fire extinguishing systems. It assists in isolating the fire by automatically cutting off electrical circuits in fans, blowers or other electrical equipment when the extinguishing system operates. It is a self-contained, mercury contact-type switch suitable for applications which employ gas or air pressure. The pressure switch is connected by a bleed pipe from the main distribution line and is operated by the carbon dioxide in passing through this distributing piping to the discharge nozzles.



Actuating Motor

Electrical Engineering & Mfg. Corp., 4606 W. Jefferson Blvd., Los Angeles 16, Calif.

Designed for cowl-flap actuation and custom-built throughout to combine an electric motor, gear reduction and control unit to fit awkward mounting conditions and limited space. The unit consists of a 1/6 hp. motor, thermally protected, equipped with magnetic clutch and brake. Shaft output is 8 in-lb. at 1200 rpm. Straight 8 to 1 gear reduction is available for opening and closing flaps, with double reduction and worm drive to operate cams



limiting travel of flaps. Unit is completely self-contained. As furnished for use in a 28-volt system, this motor-actuator weighs 4 3/4 pounds.

Rust Inhibiting Oil

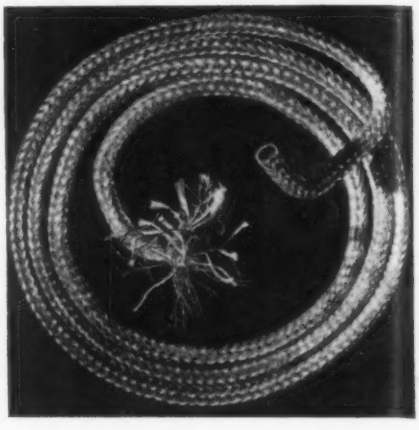
Mitchell-Bradford Chemical Co., 2446 Main St., Stratford P.O., Bridgeport, Conn.

Witch oil protects metal stampings after pressing and while in storage or transit and acts as a bond for paint or enamel. It is in use on automobile filters. Shells are degreased after pressing then dipped in the oil and shipped to point of assembly. This oil withstands the baking heat up to 250 deg. and continues to maintain a film on the interior of the shell making unnecessary the application of oil for protection between manufacture and use.

Radio Shielding Gasket

B. F. Gladding & Co., S. Otselic, N. Y.

Radio shielding sealing gasket eliminates radio and radar interference caused by high tension currents escaping through parting joints in aircraft ignition systems. The gasket is effective

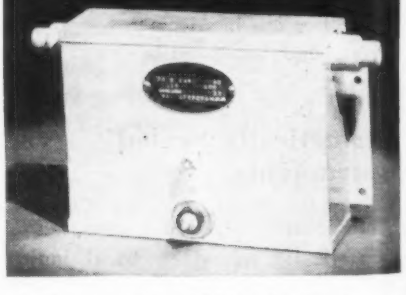


in shielding parting joints in all radio frequency ranges from 200 to 300,000 kilocycles. The construction of the gasket has two features. The outer circumference will conduct an electrical current and provide an adequate moisture proof seal. It is also effective in maintaining a pressure seal on supercharged ignition systems.

Aircraft Ignition Transformers

General Electric Co., Schenectady 5, N. Y.

Three 115-volt, 400-cycle ignition transformers, designed to give a high-voltage arc for igniting fuel in gasoline-fired, aircraft-cabin heaters and de-icers, have been announced by this company. The units are shielded and filtered to minimize radio interference over all wave bands from 110 kilocycles to 200 megacycles. Two of the transformers, with an output capacity of 6,000 volts each, are of the single-secondary type. The third has a double secondary, with each

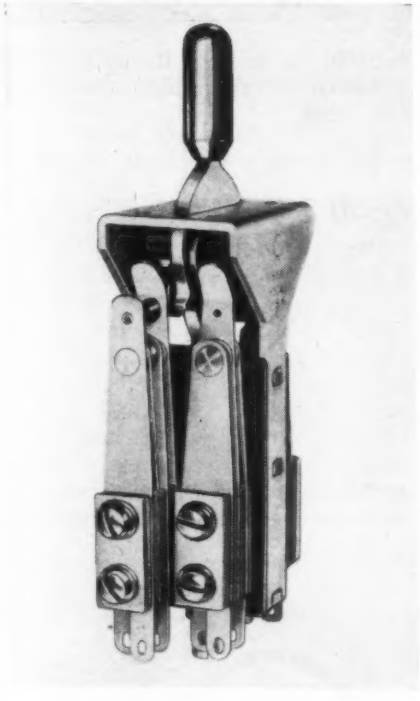


winding rated at 6,000 volts for heaters with dual ignition or for two separate heaters with single-ignition systems. The units are housed in plated-steel cases and all coils are imbedded in a specially developed high-melting-point, moisture-resistant insulating compounds. They operate over a range of ambient temperatures from —70 to 140 deg. F. at altitudes from sea level to 45,000 feet.

Heavy Duty Lever Switch

Donald P. Mossman, Inc., 612 North Michigan Ave., Chicago 11, Ill.

Series 4101 heavy duty lever switch is used for motor starting, stopping, reversing, and motor plugging. The design affords flexibility of circuit arrangements, and an almost unlimited series of combinations of contact assemblies are available. The illustration

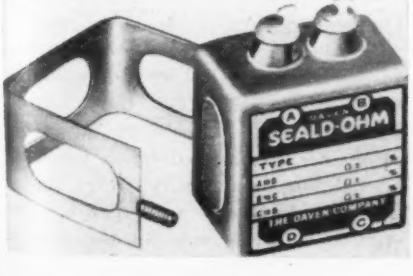


shows a series 4101 switch with contacts rated at 20 amp., 110 volts, a.c. (non-inductive). Contacts of 10 amp. are available.

Sealed Resistor

Daven Co., 191 Central Ave., Newark 4, N. J.

Seald-Ohm wire-wound resistors are hermetically sealed precision units whose construction and flexibility of mounting make them adaptable to extremes of humidity and temperature. The resistor elements are mounted in a drawn brass case. Connections are brought out through fused glass seals, soldered in the case. These resistors



may be employed as secondary standards, resistor elements in bridge networks, in voltage divider circuits and in attenuation networks. Dimensions are: 1 9/16 in. wide, 1½ in. high, 7/8 in. deep; add terminal height, 9/16 inch.

Transparent Tape

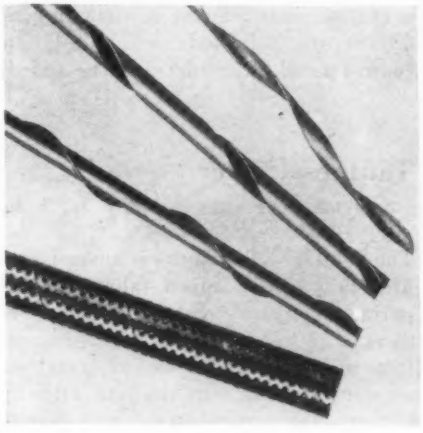
Irvington Varnish & Insulator Co., 6 Argyle Terrace, Irvington, N. J.

A transparent, flexible thermoplastic tape has been introduced. Useful not only as electrical insulation, Fibron tape No. 3 also protects wiring, cables, and equipment against abrasion. The tape is heat sealing, flame resistant, flexible at low temperatures, and resists attacks by acids, alkalies, moisture, oil, grease and corrosive fumes. With proper adhesives, it may be bonded to fabrics, metal, ceramics, wood, and other materials. Fibron tapes have been applied successfully as gasketing material; in the construction of automotive and aircraft lighting and ignition harnesses; and in the splicing of plastic insulated wire and cable.

Coiled Strip Tubing

Agaloy Tubing Co., 1027 Newark Ave., Elizabeth 3, N. J.

A strong tubular structure without welding or brazing is made by a method which stretches strip in a longitudinal direction during coiling operations. This development is devoted to coiling cold rolled strip into tubular forms, such as spirally coiled tube with inside or outside fins; edges overlapped with the protrusions either inside or outside; and open seamed coils to accurate dimensions.



Driver Units

University Laboratories, 225 Varick St., New York 14, N. Y.

Permanent magnet driver units have design features which include molded diaphragm flexing surfaces, heatproof

voice coil suspensions, and hermetically sealed dust covers. Another feature is rim centering of voice coil assembly in the magnetic gap, instead of the use of aligning pins. The rim centering method results in permanent positioning of the voice coil assembly.

Spring Lock Washers

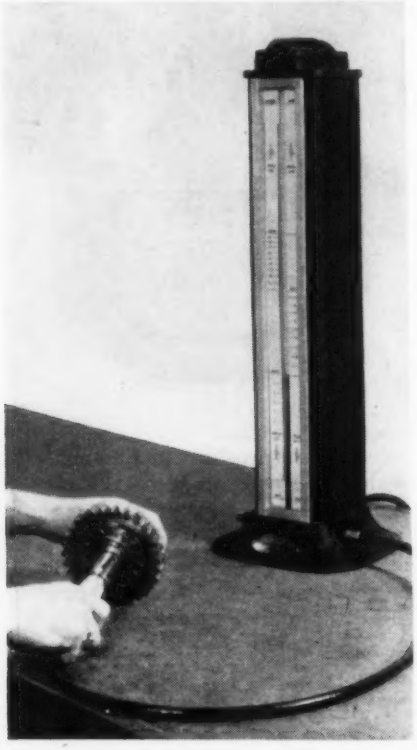
George K. Garrett Co., 1421 Chestnut St., Philadelphia 2, Pa.

Double-coil spring lock washers are claimed to have great reactive spring pressure, plus resistance to shock and vibration. They are recommended for use on grading, bulldozing, agricultural equipment and other types of heavy machinery. These washers are furnished in sizes for No. 4 screws up to 1 in. and larger bolts, in any desired finish.

Air Gaging System

Federal Products Corp., 1144 Eddy St., Providence 1, R. I.

This system consists of a graduated column, and a gaging head. A manometer tube, built into the water column, indicates variations in air pressure. The standard gaging head is constructed with two measuring orifices which are recessed with respect to the outer skirt of the gaging member. As the space between the measuring orifices and the

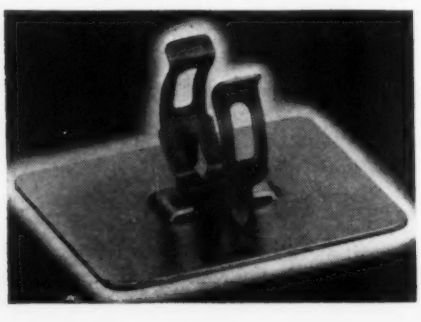


part being gaged increases, the air flow increases and the water column rises in the manometer tube. This results in a plus reading when gaging a hole diameter. If the diameter of the hole being gaged is undersize, the air flow is decreased, and this is expressed by a minus reading on the scale. Holes as small as 0.156 in. diameter and shoulders as narrow as 0.0937 in. can be precisely measured. Slots and grooves can be gaged from 0.0937 in. thick and up. Gaging heads in general will measure external diameters from 0.500 in. dia. up.

Capacitor Mounting Clip

Prestole Div., Detroit Harvester Co., 4500 Detroit Ave., Toledo, Ohio.

A universal capacitor mounting clip, which can be attached to the chassis with one hand motion and without assembly tools of any kind, has been announced. The pointed retaining tongues of the clip bite into the chassis and prevent any loosening due to vibration.

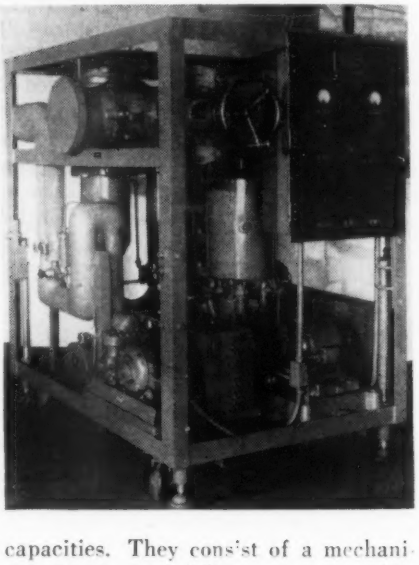


Clips may be riveted to the chassis wherever an embossure has not been provided. All clips are designed to fit chassis thicknesses from 0.032 to 0.062; thus all clips, regardless of diameter, will fit one standard chassis embossure. Sizes of clips presently available range from 5/8 in. up to 1 3/8 inch.

High Vacuum Pumps

National Research Corp., Boston 15, Mass.

Complete high vacuum systems Type PS, in compact unit for direct connection to system, are available in various

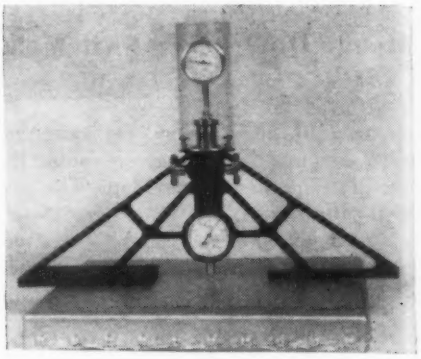


capacities. They consist of a mechanical forepump, diffusion pump, high vacuum valves, gauges, and control panel. Mechanically refrigerated traps can be built in on special order. The PS systems need only one connection. The unit is fully automatic and incorporates safety features. Vacuum conditions are indicated continuously on control panel. Recorders may be added.

Tautness Meter

Sherman W. Frazier, 953 15th St., S. E., Washington 3, D.C.

The Schiefer-Kline tautness meter measures tautness of doped fabrics of experimental panels and of airplane sections. The instrument is placed in contact with the fabric-covered panel or airplane section with the foot midway between the rib spacings. The foot is lowered upon the specimen until the load on the fabric is 3 ounces. A reading of the lower dial is then taken. The load on the fabric is increased to 19 ounces and a second reading of the lower dial is taken. The difference between the two readings is the deflection

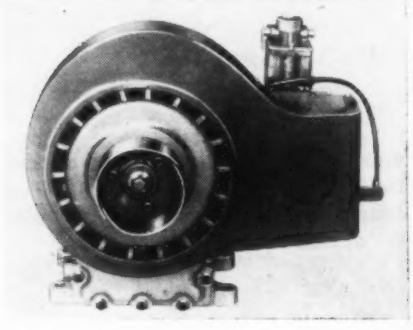


in 0.001 in. under 1 lb. load. A low deflection indicates a high tautness and vice versa.

Small 5 Hp. Engine

Kinner Motors, Inc., Glendale 4, Calif.

A 5 hp. all-purpose air-cooled small engine has been announced. The Kinner model AB-3 is an air-cooled, 4-cycle, L-head engine rated 5 hp. at 2600 rpm., but develops 6 hp., at 3250 rpm. The single cylinder is horizontal and detachable, making maintenance easier. Bore is 2 3/4 inches, stroke 3 inches, displacement 17.8 cubic inches. The whole unit requires only 2.4 cubic feet



of space. It is claimed to be the lightest engine on the market in its horsepower class. Aluminum alloy is used in crankcase, piston, crankcase cover and rear cover. Power take-off is 1 in. in diameter, and rotates counter-clockwise facing the shaft.

Chemical Finish for Steel

Du-Lite Chemical Corp., of Middletown, Conn.

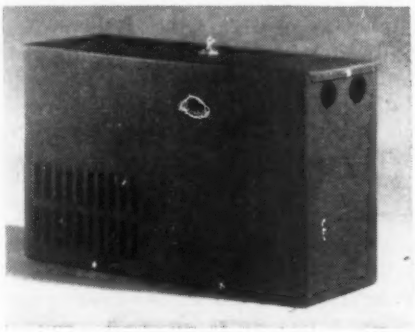
Du-Lite Phosteel, a phosphate type finish for iron and steel, is the result of research by the Du-Lite Fellowship established at Syracuse University in 1944. This finish, with an oil dip, is satisfactory as a final finish for many applications, since it provides protection from rust. It is used as a base for organic finishes, because the crystal-

line surface of the porous coat grips the paint or lacquer so that chipping or peeling is almost impossible. It meets Army specifications for this type finish and no license is required to use the process.

Electronic Rectifiers

Davis & Murphy, 5252 Broadway, Chicago 40, Ill.

EPCO magnetic chuck rectifiers are a new development in industrial electronic control to convert 110 volts a.c. to 110 volts d.c. They embody full wave rectification by electronic tubes mounted on shock proof bases, precision built transformers, condensers and

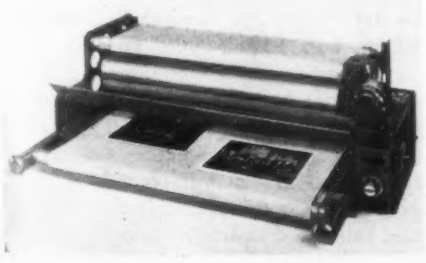


easily replaced protection fuse. EPCO No. 2 delivers 2 amp. at 110 volts d.c. and EPCO No. 6 delivers 6 amp. at 110 volts d.c. Two of the No. 6 units can be used where requirements call for 12 amp. output; three can be used for 18 amp. output.

Photoprint Dryer

Peck and Harvey, 4327 Addison St., Chicago 41, Ill.

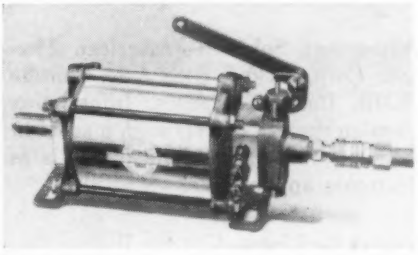
"B-8" photo dryer operates with electrical heating elements that maintain even heat. It dries matte, semi-matte or glossy prints, as well as blue prints or black-and-white prints. Thermostatic control is available. Variable speed drive motors and controllers permit instantaneous speed changes over a range of 6 in. to 3½ ft. a minute. A chromium plated copper drum that gives a glossy surface is included. Two sizes are available: 26 in. and 44 in. widths.



Air Motor

Bellows Co., Akron 10, Ohio.

Bellows BM10 air motor develops more than twice the piston thrust force of the standard BM5 motor on a given air line pressure. The air motors are small, compact air-driven reciprocating power units. They operate on any air line pressure up to 175 lb. They differ from conventional air cylinder design in that the valve and all operating controls are integral with the cylinder, permitting control over all operating phases at all



times. Independent speed control valves provide speed control of piston rod advance and retraction. The valve operating lever is adjustable to any angle permitting synchronization to any reciprocating machine movement.

Pressure Switch

Pressure Switch Div., Cook Electric Co., 2700 Southport Ave., Chicago 14, Ill.

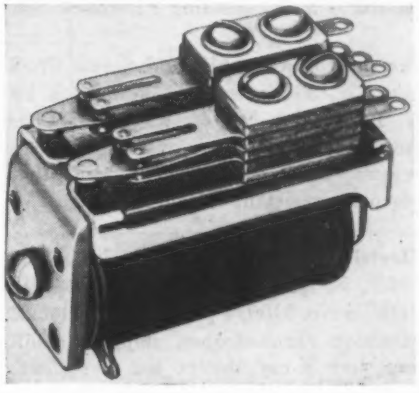
A pressure switch, for controlling hydraulic pressures and cutting off circuits at predetermined pressures, and for controlling surge loads, called the "Hi-Pressure" switch, is capable of withstanding 3,000 lb. surge load, with a range of adjustment from 100 to

2,000 lb. with a 20 lb. differential at 100 lb. pressure which increases proportionately at higher pressures. The electrical capacity of this switch is 10 amp. at 125 volts a.c., S.P.D.T. with either an Amphenol connection or a standard conduit fitting. The pressure connection can be either 3/8 in. or 1/8 in. standard pipe thread. The switch weighs 2 lb. approximately.

Telephone-Type Relay

Potter & Brumfield Mfg. Co., 231 Linden St., Princeton, Ind.

Weighing 1¾ oz. a miniature relay known as the "MT" series is announced. This midget relay is sensitive enough to operate on minute current, but twin contacts exert the high contact pressure needed for perfect closure. It is resistant to vibration, and is constructed for mounting in a limited space. Over-all dimensions with two type C contact assemblies are: Length 1½ in., height



1 7/32 in., width 11/16 in. Operating voltage up to 60 volts d.c. Frames are provided with 4 mounting holes tapped 3-48, spaced 3/8 in. center to center. Relay is available in all contact arrangements of forms A, B and C.

Surface Roughness Standards

Surface Checking Gage Co., Hollywood 28, Calif.

To meet the trend toward uniformity in surface control, Surf-Chek roughness standards have been produced. They are a development of J. A. Broadston of North American Aviation, Inc. A series of four articles on surface roughness measuring methods, by Mr. Broadston, appeared in the Sept., Oct., Nov. and Dec. 1944 issues of PRODUCT ENGINEERING. The kit contains a 65 page educational text bound to a gage consisting of 20 replicas of machined surfaces, prepared by turning, grinding, milling, honing, lapping and polishing, which vary in roughness from 500 to 5 microinches. The replicas are molded into a 5x7 in. plastic plate through the use of precise die inserts.

Manufacturers' Publications

Plastics—General Electric Co., 1285 Boston Ave., Bridgeport, 2, Conn. Booklet, 20 pages. Plastics molding and fabricating facilities of this company are described.

Belt Hooks—The Bristol Co., Waterbury 91, Conn. Bulletin 737, 6 pages. The product is illustrated and method of application is described.

Rubber Adhesives—B. F. Goodrich Co., Akron, Ohio. Booklet, 12 pages. Natural and synthetic rubber cements are described. Composition and applications of various types are given. Included is metal bonding Plastilock 500.

Screw Products—Allmetal Screw Products Co., 35 Greene St., New York 13, N. Y. Catalog No. 44, 83 pages. Lists stock sizes and dimensions of bolts, cap screws, nuts, pipe fittings and other corrosion-resistant fastening devices.

Electric Timers—C. H. Stoelting Co., 424-P. N. Homan Ave., Chicago 24, Ill. Bulletin No. 1100, 4 pages. Stop clocks, precision chronoscopes, impulse counters and X-ray timers are described. Included are circuit diagrams to show methods of connecting the various timers in test circuits.

Ballasts—Hudson American Corp., 25 W. 43d St., New York 18, N. Y. Catalog, 16 pages. Standard models of the Bestran ballast for fluorescent lighting units are illustrated, and electrical characteristics are listed. Dimensions are given, together with a description of component parts.

Tubes—Taylor Tubes, Inc., 2312 Wabansia Ave., Chicago 47, Ill. Catalog, 32 pages. Characteristics of tubes and technical information on transmitters and tubes used in this application are given.

Die Casting—New Jersey Zinc Co., 160 Front St., New York 7, N. Y. Booklet, 64 pages. Complete discussion of designing for die casting. Precautions are given, with special emphasis on zinc, aluminum and magnesium alloys.

Vari-Typer—Ralph C. Coxhead Corp., 333 Sixth Ave., New York 14, N. Y. The machine is illustrated and its use described. Applications, such as make up of parts lists, production forms, graphs and technical data sheets, are discussed.

Nitrocellulose Lacquers — Hercules Powder Co., Wilmington 99, Del. Leaflet, 8 pages. Uses and advantages of high-solids nitrocellulose lacquers are covered.

Polystyrene Solution—American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill. Bulletin, 6 pages. Information given on the use of Polyweld, a solution of polystyrene, as a dope for coils in electronic applications.

Leather Packings—Chicago Belting Co., Green and Washington Sts., Chicago 7, Ill. Manual, 64 pages. Describes hydraulic and pneumatic leather packings, their design and application, and dimensional standards. Contains many sketches showing packing assemblies.

Selenium Rectifiers—Fansteel Metallurgical Corp., N. Chicago, Ill. Bulletin RDP-107, 12 pages. Properties and characteristics of selenium rectifiers are listed. Circuits are described in charts and graphs.

Cerium—Cerium Metals Corp., 522 Fifth Ave., New York 18, N. Y. Bulletin, 4 pages. Selected literature and patent references regarding the use of cerium with aluminum and magnesium.

Engine Mountings — Bushings, Inc., 3442 W. Eleven Mile Road, Berkeley, Mich. Bulletin BU-23, 2 pages. Specifications and drawings of four typical rubber insulated engine mountings are given.

Ignition Transformers—General Electric Co., Schenectady 5, N. Y. Bulletin GEA-4431, 2 pages. Advantages and characteristics of 400-cycle ignition transformers for gasoline fired aircraft cabin heaters are listed.

Pressure Sealing Zipper—B. F. Goodrich Co., Akron, Ohio. Bulletin, 4 pages. Described is the zipper, which is an arrangement of overlapping rubber lips applied to a slide fastener, giving a seal against liquids and gases.

Variable Speed Drives—Worthington Pump and Machinery Corp., Harrison, N. J. Bulletin, 6 pages. Illustrates and lists engineering data of the Allspeed drives. Horsepower requirements and applications are included.

Plastics Molding — Kurz-Kasch, Inc., 1415 S. Broadway, Dayton 1, Ohio. Booklet, 16 pages. The molding of plastics is discussed from the standpoint of the non-technical executive. Data on production facilities of this company is given.

Automatic Valves—A. W. Cash Valve Mfg. Corp., Decatur 60, Ill. Bulletin, 24 pages. Various types of Cash Acme valves are described and listed. Each type is illustrated, and complete specifications are given.

Power Transformers—Standard Transformer Co., Warren, Ohio. Bulletin No. S-402, 20 pages. Component parts and design of transformers are explained. Ratings, dimensions and weights of various models are given. Special models are illustrated.

Casting Sealants—Plastics Div., Monsanto Chemical Co., Springfield 2, Mass. Bulletin X-100-2, 12 pages. Properties of the Thalid X-100 series of resins for sealing aluminum and magnesium castings are discussed. Compositions and methods of impregnation are also given. Various physical properties are explained by means of graphs.

Plastics Fabricating—Teckna Co., 223rd St. & Northern Blvd., Bayside, N. Y. Booklet, 10 pages. Production facilities of this company are described and illustrated.

Electronic Controls—Wheelco Instruments Co., Harrison & Peoria Sts., Chicago, Ill. Bulletin No. Z-6300, 12 pages. Temperature, indicating pyrometer, input and program controllers, potentiometers and thermocouples are listed.

Washers, Rings, Studs—Prenco Progress & Engineering Corp., 72-74 Stafford St., Toronto, Canada. Manual S-2, 75 pages. Griplox pins and washers, Truarc retaining rings, Groov-Pins, Drive-Studs and Cherry Blind Rivets, are cataloged and illustrated.

Electrical and Mechanical Equipment —Lear, Inc., Piqua, Ohio. Catalog, 232 pages. Gives complete engineering data on linear actuators, rotary actuators, power units, screw jacks, flexible shafting and accessories, motors and controls which are manufactured by this company. Contains installation drawings, tabulated charts of specifications, and load and performance curves.

Physical Properties of Cellulosic Plastics

CELANESE PLASTICS CORPORATION

FLOW SYMBOLS on the accompanying charts are arbitrarily assigned to designate the flow or plastic hardness of the cellulosic plastics for which test data are given. Table I gives the dry flow temperature for each flow symbol. Tolerances are plus or minus 1.5 to 2.5 deg. C., the tolerance being less in the softer flow range.

The cellulose acetate molding materials used in these tests fall in the "R" group ASTM classification for conditioning. The test specimens were conditioned in accordance with the ASTM method: D 706-43T, Tentative Specifications for Cellulose Acetate Molding Compounds. All test specimens were shaped according to ASTM requirements as indicated.

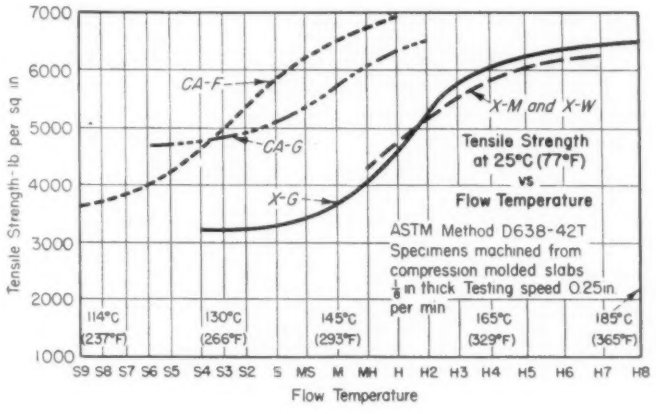
The symbols used to designate materials on the charts are

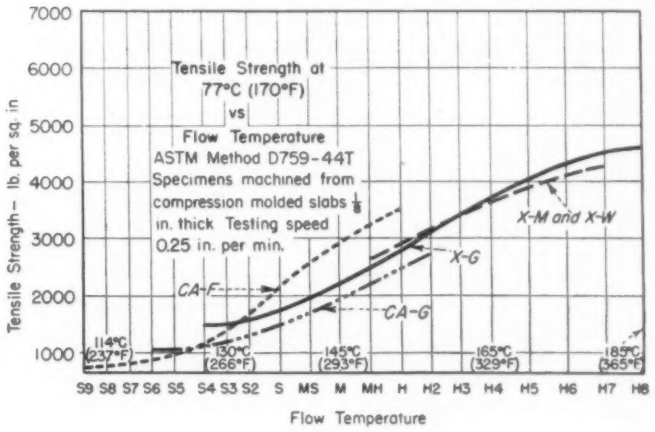
CA = cellulose acetate
X = high acetyl

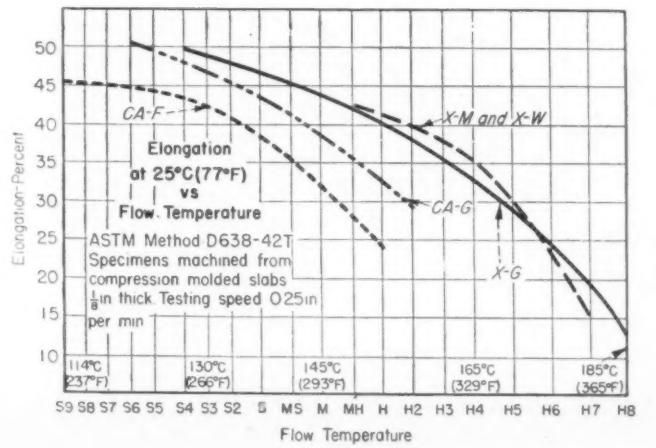
The letters *F*, *G*, *M*, and *W*, which follow the material symbol, refer to type of formulation.

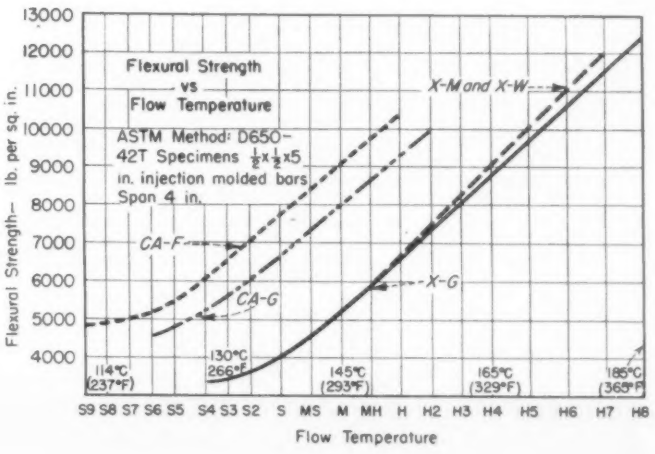
Table I—Dry Flow Symbols for Injection, Compression and Extrusion Molding

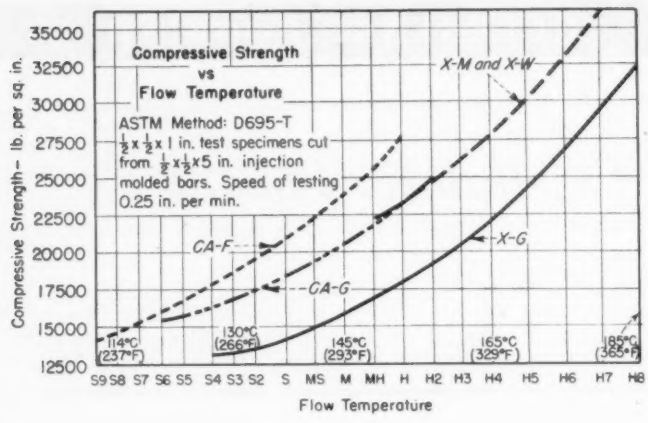
Symbol	Flow Temperature Deg. C.	Flow Temperature Deg. F.	Symbol	Flow Temperature Deg. C.	Flow Temperature Deg. F.
H8	185	365	*MS*	141	286
H7	180	356	*S*	137	279
H6	175	347	*S2*	133	272
H5	170	338	*S3*	130	266
H4	165	329	*S4*	127	260
H3	161	322	*S5*	123	254
H2	157	315	*S6*	120	248
H	153	307	*S7*	117	242
MH	149	300	*S8*	114	237
M	145	293	*S9*	111	232

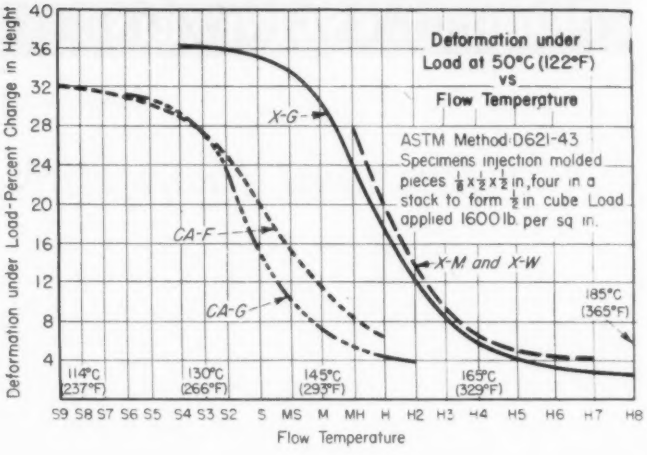

Tensile Strength-lb per sq in
CA-F
CA-G
X-G
X-M and X-W
Tensile Strength at 25°C (77°F) vs Flow Temperature
ASTM Method D638-42T Specimens machined from compression molded slabs 1/8 in thick Testing speed 0.25 in per min
114°C (237°F)
130°C (266°F)
145°C (293°F)
165°C (329°F)
185°C (365°F)
S9 S8 S7 S6 S5 S4 S3 S2 S MS M MH H H2 H3 H4 H5 H6 H7 H8
Flow Temperature

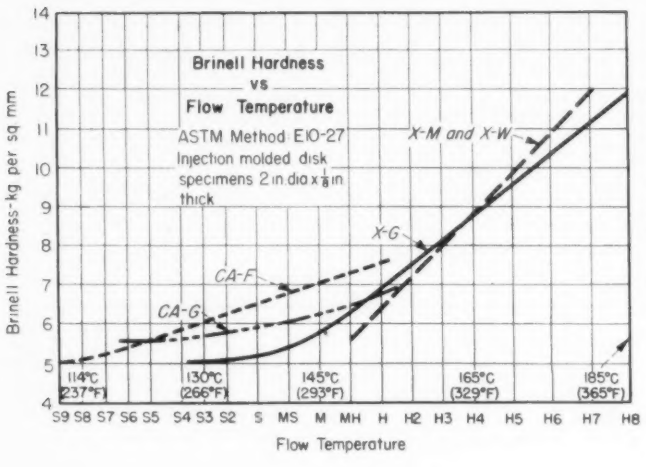

Tensile Strength – lb. per sq. in.
Tensile Strength at 77°C (170°F) vs Flow Temperature
ASTM Method D759-44T Specimens machined from compression molded slabs 1/8 in. thick Testing speed 0.25 in. per min.
CA-F
CA-G
X-G
X-M and X-W
114°C (237°F)
130°C (266°F)
145°C (293°F)
165°C (329°F)
185°C (365°F)
S9 S8 S7 S6 S5 S4 S3 S2 S MS M MH H H2 H3 H4 H5 H6 H7 H8
Flow Temperature

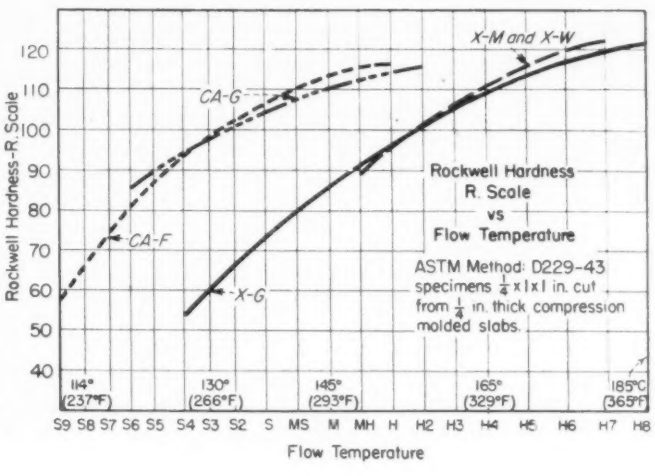

Elongation-Percent
CA-F
CA-G
X-G
X-M and X-W
Elongation at 25°C (77°F) vs Flow Temperature
ASTM Method D638-42T Specimens machined from compression molded slabs 1/8 in thick Testing speed 0.25 in per min
114°C (237°F)
130°C (266°F)
145°C (293°F)
165°C (329°F)
185°C (365°F)
S9 S8 S7 S6 S5 S4 S3 S2 S MS M MH H H2 H3 H4 H5 H6 H7 H8
Flow Temperature

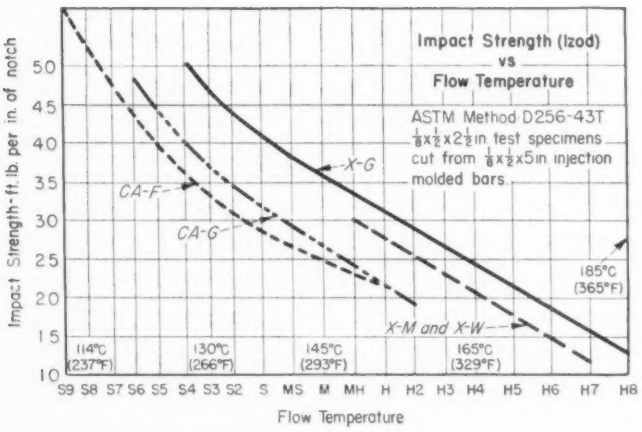

Flexural Strength – lb. per sq. in.
Flexural Strength vs Flow Temperature
ASTM Method: D650-42T Specimens 1/2 x 1/2 x 5 in. injection molded bars Span 4 in.
CA-F
CA-G
X-G
X-M and X-W
114°C (237°F)
130°C (266°F)
145°C (293°F)
165°C (329°F)
185°C (365°F)
S9 S8 S7 S6 S5 S4 S3 S2 S MS M MH H H2 H3 H4 H5 H6 H7 H8
Flow Temperature

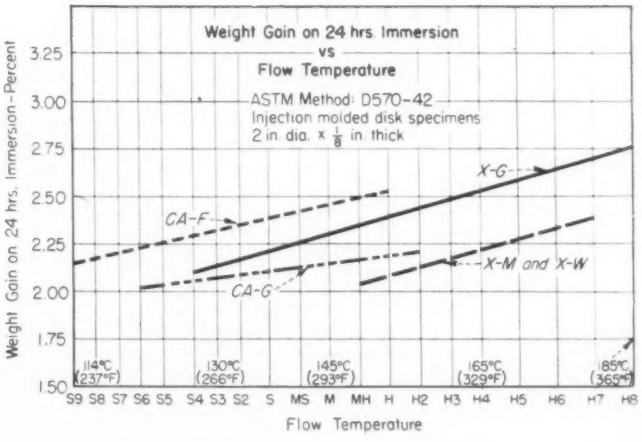












PRODUCT ENGINEERING — REFERENCE BOOK SHEET

Low Cost

What is the real cost of a bearing? Is it the purchase price alone? The length of service and the kind of performance delivered? Does the installation—maintenance and repair costs enter into it?

The real cost includes all of these . . . and more.

Postwar competition will force all manufacturers to deliver the highest quality at the lowest price. Your first step, when specifying bearings, is to be absolutely sure of the type. There is *one* correct bearing for each application. The bearings should be manufactured and finished in such a way as to cut installation costs to a minimum They should be interchangeable Finally, the quality should enable you to guarantee the length of service . . . in years . . . with a minimum of attention.

Our many years of wide experience enables us to give good sound advice to manufacturers of all types of products. Our manufacturing facilities plus our skilled personnel enables us to produce bearings strictly according to specifications. *Now* is the time to consult with us on your future bearing requirements. Remember—the most expensive bearing in the world . . . is the one that fails.

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508 S. MILL STREET • NEW CASTLE, PA.

VICTORY COMES FIRST

All our present production is for Armament

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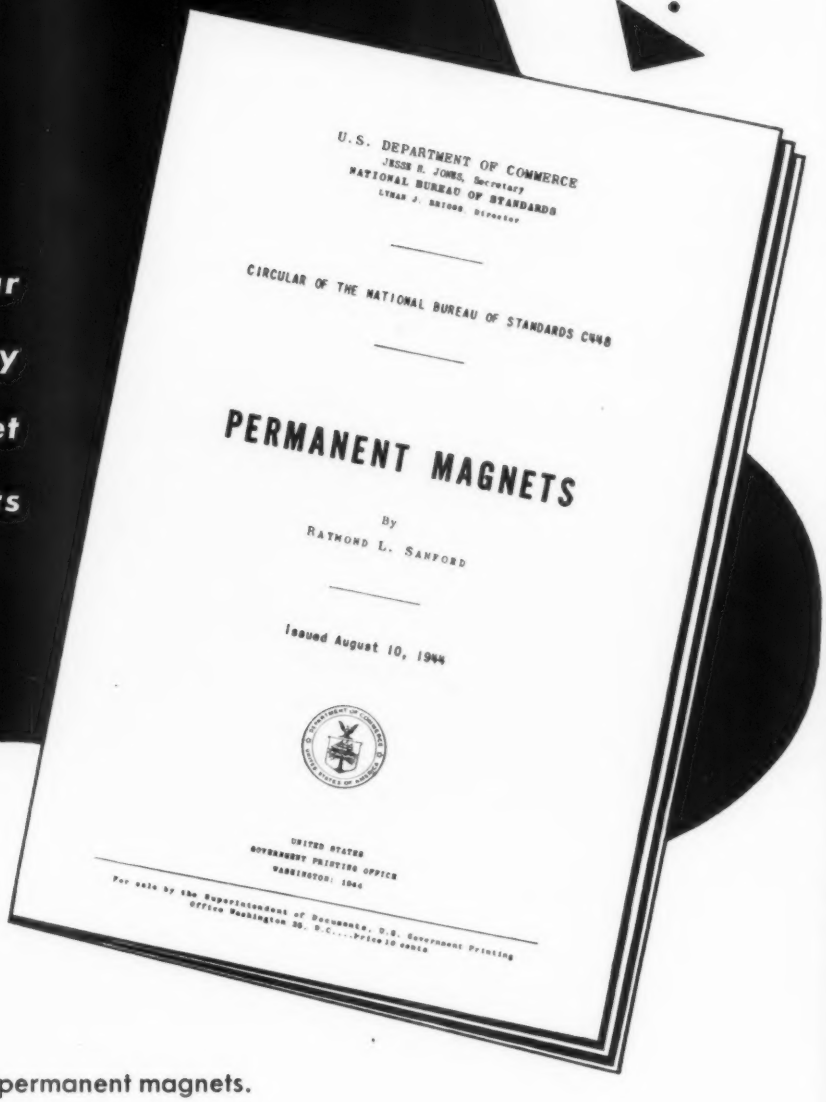
Just write us, on your letterhead, for your copy of this valuable booklet on permanent magnets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CIRCULAR OF THE NATIONAL BUREAU OF STANDARDS C448

PERMANENT MAGNETS

By
RAYMOND L. SANFORD

Issued August 10, 1944

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON: 1944

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. - Price 10 cents

● As a service to industry, The Arnold Engineering Company is "lending a hand" in the distribution of what Arnold engineers believe to be a very informative study on the subject of permanent magnets.

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Specialists in the Manufacture of ALNICO PERMANENT MAGNETS

ARE YOU DEVELOPING A PRODUCT THAT REQUIRES A SPECIAL APPLICATION FRACTIONAL HORSEPOWER MOTOR..?

IF so, we would like to make this recommendation: to obtain the maximum advantages of *special application,* be sure to consider the motor in the *early* stages of product development.

Among the important advantages offered by Lamb Electric special application motors are:

1. Lower weight and greater compactness resulting from *special* motor design.
2. Streamlined appearance because motor can be styled for the product.
3. Good product performance because of a thoroughly engineered, dependable motor.

Our experience covering all types of fractional horsepower motors is available to your engineering department.

THE LAMB ELECTRIC COMPANY
KENT, OHIO

Base-mounted, explosion-proof shrouded gear fuel transfer pump motor.
Light-weight universal motor with efficient spur gear speed reducer.
Universal motor having extremely rugged performance characteristics and construction.
Light-weight universal motor specially designed for portable devices.
Outstanding fan motor design in appearance, as well as mechanical detail.

THOROUGH ENGINEERING

is the basic factor behind the successful operation of the special application motors shown here and many others we have designed and built for all types of equipment.

FORMERLY Lamb Electric Black & Decker Electric

SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

ACROSS-THE-LINE TYPE without overload protection

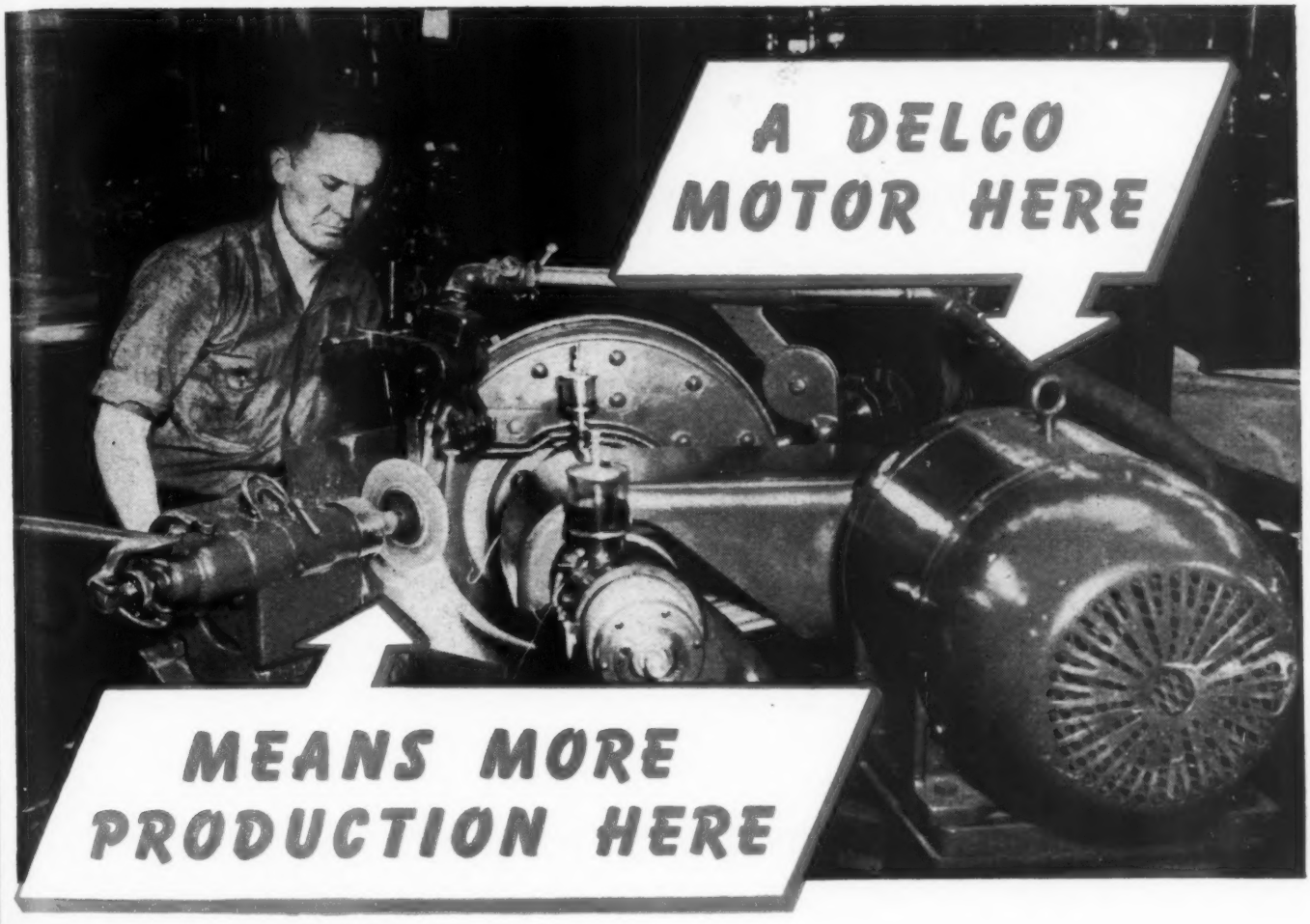
Everywhere relied upon to give positive control of motors; especially suitable for oil burners, refrigerators, motor-driven machinery and lighting loads.

These switches have rugged, durable mechanisms built to perform with the sturdy integrity characteristic of Arrow-H & H Lines. Bakelite arc snuffers increase breaking capacity; kick-off release mechanically starts the switch blades in motion and prevents sticking; extra-heavy blades and contact jaws increase current-carrying capacity. Different styles of mounting are supplied for a wide range of machine-design requirements. Separate switch units are available for installations in switch housings built into motor-driven machinery.

No. 6808 (upper and lower right) is a double-pole switch for single phase motors; No. 7808 (upper and lower left) is 3-pole for 3-phase jobs. This new, improved "7808" combines greatly increased mechanical life with *reduced size* approximately one-half of its former dimensions. The line includes 3-way, 4-pole and 2-speed reversing switches. All have horsepower ratings. . . Everything you may need in this line will be found in Motor Starting Switch Catalog No. 9-M — on request.

INDUSTRIAL CONTROL DIVISION

THE ARROW-HART & HEGEMAN ELECTRIC COMPANY, HARTFORD, CONN., U.S.A.



THESE DELCO MOTOR FEATURES KEEP MACHINE TOOLS ON THE JOB

1. Cartridge-Type Ball Bearings
2. Large Grease Reservoir
3. Dynamically Balanced Rotor
4. Sturdy, Rigid Frame
5. Taped Coils
6. Selective Shaft-Bearing Fit
7. Straight-Flow Ventilation

KEEP BUYING WAR BONDS

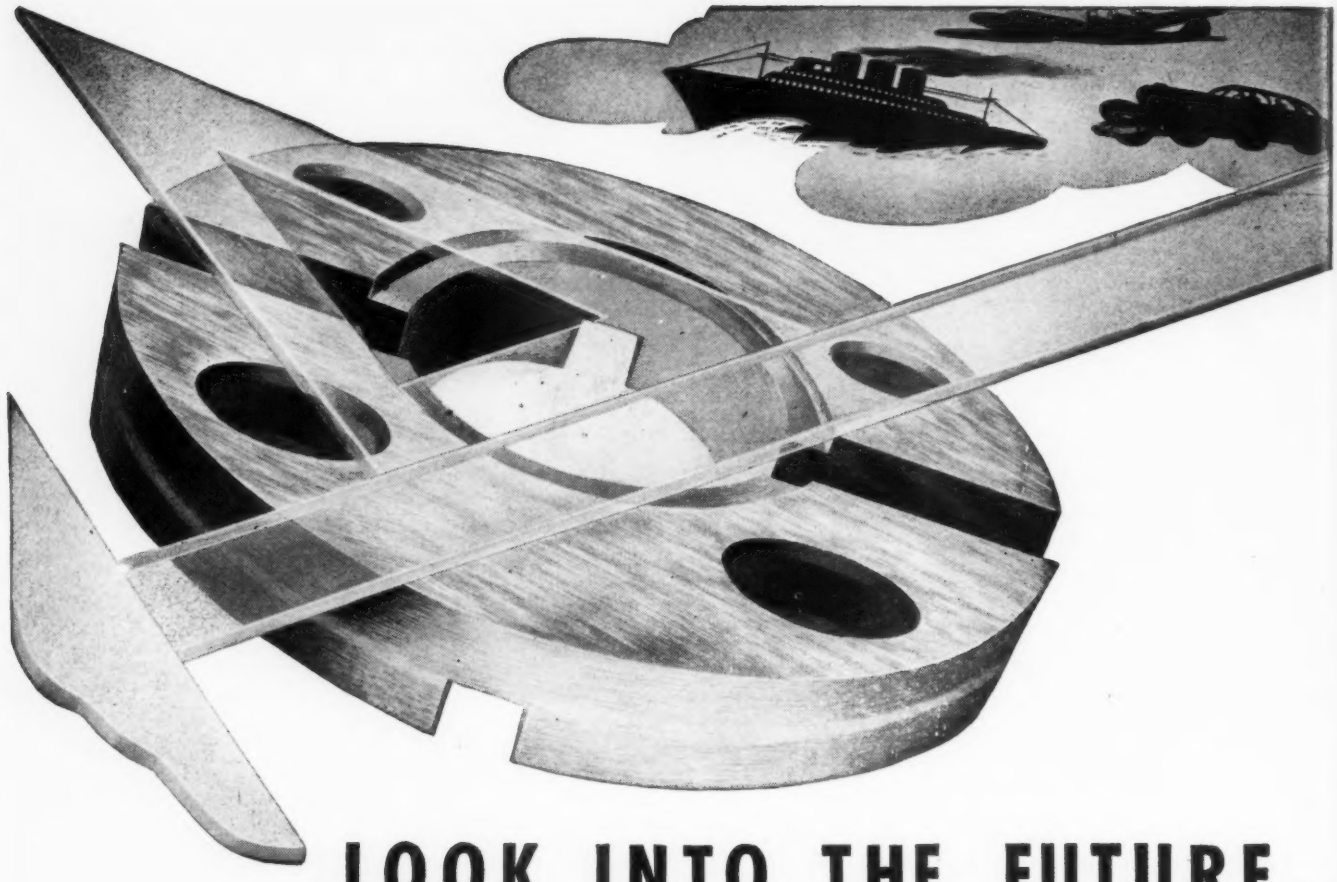
With the ever-increasing demand for more and more production, Delco Products engineers directed their years of experience to clearing up motor "trouble spots" reported in factory records. The Delco motors serving industry today are the result. They are built to give extra protection against insulation burn-out, bearing failure, misalignment . . . scientifically designed to meet the particular requirements of machine tool applications.

Through long, dependable performance, Delco motors aid materially in keeping essential equipment working at capacity and production on schedule.

DELCO MOTORS

DIVISION OF GENERAL MOTORS CORPORATION

DELCO PRODUCTS DAYTON, OHIO



LOOK INTO THE FUTURE...

The VULCOID part illustrated is a magneto coupling. It must have great mechanical strength, be moisture resistant, insulate electrically; and have sufficient resilience to absorb the shocks of starting and stopping.

When you are projecting your future products Continental-Diamond Technicians can help you design for the appropriate NON-metallic material.

C-D manufactures 6 distinctly different types of NON-metallic materials. These materials have helped solve thousands of mechanical, electrical, chemical and thermal design problems.

Whether your requirements dictate *plastics, vulcanized fibre, mica* or some other type of NON-metallic material C-D "Know-how" can help you.

KC-45

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The Plastics

DILECTO—A Laminated Phenolic.
CELORON—A Molded Phenolic.
DILECTENE—A Pure Resin Plastic Especially Suited to U-H-F Insulation.
HAVEG—Plastic Chemical Equipment, Pipe, Valves and Fittings.

The NON-Metallics

DIAMOND Vulcanized FIBRE
VULCOID—Resin Impregnated Vulcanized Fibre.
MICABOND—Built-Up Mica Electrical Insulation.

Standard and Special Forms

Available in Standard Sheets, Rods and Tubes; and Parts Fabricated, Formed or Molded to Specifications.

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Established 1895.. Manufacturers of Laminated Plastics since 1911—NEWARK 40 • DELAWARE

HOW RCA TUBES INCREASED OUTPUT OF PLASTIC PARTS 400%

Electronic Preheating Cut Rejects, Shortened Operational Time, Simplified Molding of Intricate Plastic Parts at Kurz-Kasch

This 2000-watt RCA electronic generator can preheat one pound of plastic molding material to 275°F in about 40 seconds

IN July 1943, Kurz-Kasch, Dayton, Ohio, plastics molder, was called upon to deliver a large quantity of high-priority molded pieces within a few weeks. Because the pieces were difficult to mold, rejects due to poor preheating ran as high as 65%; production of the required quantity seemed impossible to achieve in the time available.

Electronic Preheating Tried: Tests were made with electronic preheating, and the method proved successful. In actual practice, electronic preheating cut overall operational time by 50%. Thus, disregarding rejects, production would have been doubled. But, the reduction in rejects brought the total usable output to *5 times its former level*—a 400% increase!

Job Details: The material used in this molding job was Melmac No. 592. The preforms weighed 370 grams, measured 4 inches across and 1½ inches in thickness. A large number of metal inserts were included. Electronic preheating time was only 45 to 50 seconds.

How Electronic Heating Works: By means of RCA electron tubes, 60-cycle commercial power is changed to power at a frequency of several million cycles per second. When this power is passed through the preform it generates heat *within the preform.*

Advantages of Electronic Preheating of Plastics: Heat is instantaneous and uniform throughout the preform pellet. When the power is shut off, heating stops immediately; there is no residual heat to coast temperatures beyond desired limits. With thermosetting plastics, which set with the application of high temperatures, the quick heating possible with electronic heat permits greater workability and results in fewer rejects. Production-line techniques can be employed, cutting processing time to a few minutes—or even seconds.

The Fountainhead of Modern Tube Development is RCA

62-4336-37

Working conditions are improved because no excess heat is dissipated into the work area; there are no gases or vapors to contend with. Electronic heating is noiseless, vibrationless, requires no special foundation or installation expense, and takes little floor space. Electronic-heating equipment is also a high-power-factor (90%) load on the plant electric-system.

Turn to Electronics for Solution of Your Own Problems: For information on the electronic-heating equipment used in this application, write to RADIO CORPORATION OF AMERICA, Electronic Apparatus Section, Camden, N. J.

Electron tubes are providing a practical solution to hundreds of diversified manufacturing problems—process control, machine control, heat-treating of metals, plant protection, and a host of others. Consult with RCA tube-application engineers for information or advice on the application of electron tubes in your own plant. For examples of electronics at work in industry, send for a copy of the free booklet, "16 Examples of Electron Tubes at Work In Industry." Write to RCA, Commercial Engineering Section, Dept. 62-57Y, Harrison, N. J.

RCA

RADIO CORPORATION OF AMERICA

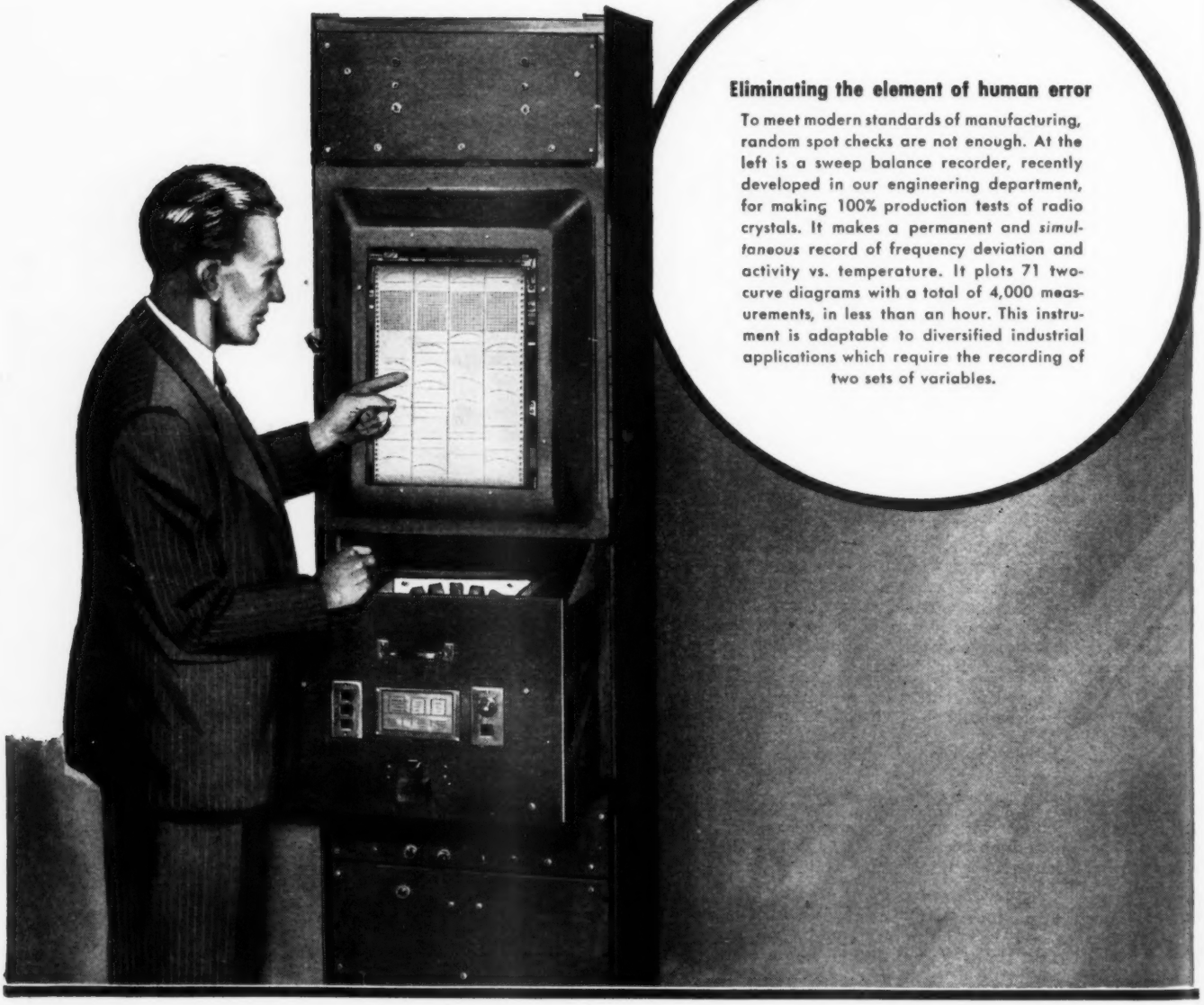
RCA VICTOR DIVISION • CAMDEN, NEW JERSEY

"GREATNESS IS NOTHING BUT MANY SMALL TRIFLES"

Old Proverb

The precision required of Connecticut Telephone & Electric Division's production keeps us on our toes . . . developing new and better manufacturing methods . . . devising improved techniques of quality control. One example is the crystal tester developed by our engineers which gives us a quality check in quantity.

This is one of many special instruments in Connecticut Telephone & Electric Division's plants. Each is designed to assure our armed forces of better products. Each one contributes its trifle of greater dependability and higher accuracy to the electronic and communications equipment you will use after the war.



Eliminating the element of human error

To meet modern standards of manufacturing, random spot checks are not enough. At the left is a sweep balance recorder, recently developed in our engineering department, for making 100% production tests of radio crystals. It makes a permanent and *simultaneous* record of frequency deviation and activity vs. temperature. It plots 71 two-curve diagrams with a total of 4,000 measurements, in less than an hour. This instrument is adaptable to diversified industrial applications which require the recording of two sets of variables.

CONNECTICUT TELEPHONE & ELECTRIC DIVISION

GREAT AMERICAN INDUSTRIES, INC. • MERIDEN, CONNECTICUT

"BO" POWER RELAY

The "BO" relay is an all-purpose double pole power relay. Like other Allied types it is ruggedly designed yet features compactness and minimum weight. This relay utilizes molded Bakelite insulation throughout. Contact rating is 15 amperes at 24 volts DC or 110 volts AC non-inductive. The "BO" relay can be furnished normally open, normally closed or double throw and is available for either AC or DC service. Weighs 4 ounces.

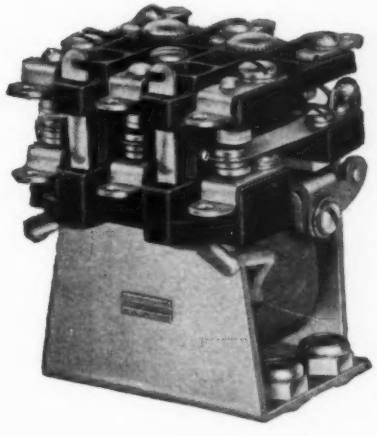
Height 1⅞"; Length 1⅝"
Width 1 13/32"

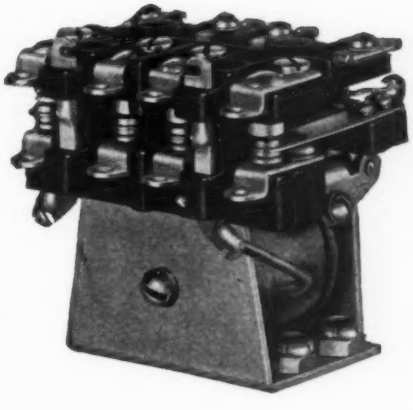
constant progress MARKS ALLIED RELAY DESIGN

"DO" TYPES 3 and 4 POLE

The "DO" three and four pole relay is similar in function to the "BO" type described above. It supersedes the old three and four pole type and features such modifications as simplified terminal arrangements, adjustable contacts, and improved mechanical structure. By using molded Bakelite insulation throughout, greater electrical clearance is provided. Contacts are rated at 15 amperes at 24 volts DC or 110 volts AC non-inductive. Can be furnished normally open, normally closed, double throw and for AC or DC service as specified. Weight for three pole type 7 oz., four pole 7½ oz.

Three pole Height 2¼"; Length 1⅝"; Width 1⅞"; Four pole Height 2¼"; Length 2 1/16" Width 1⅞".



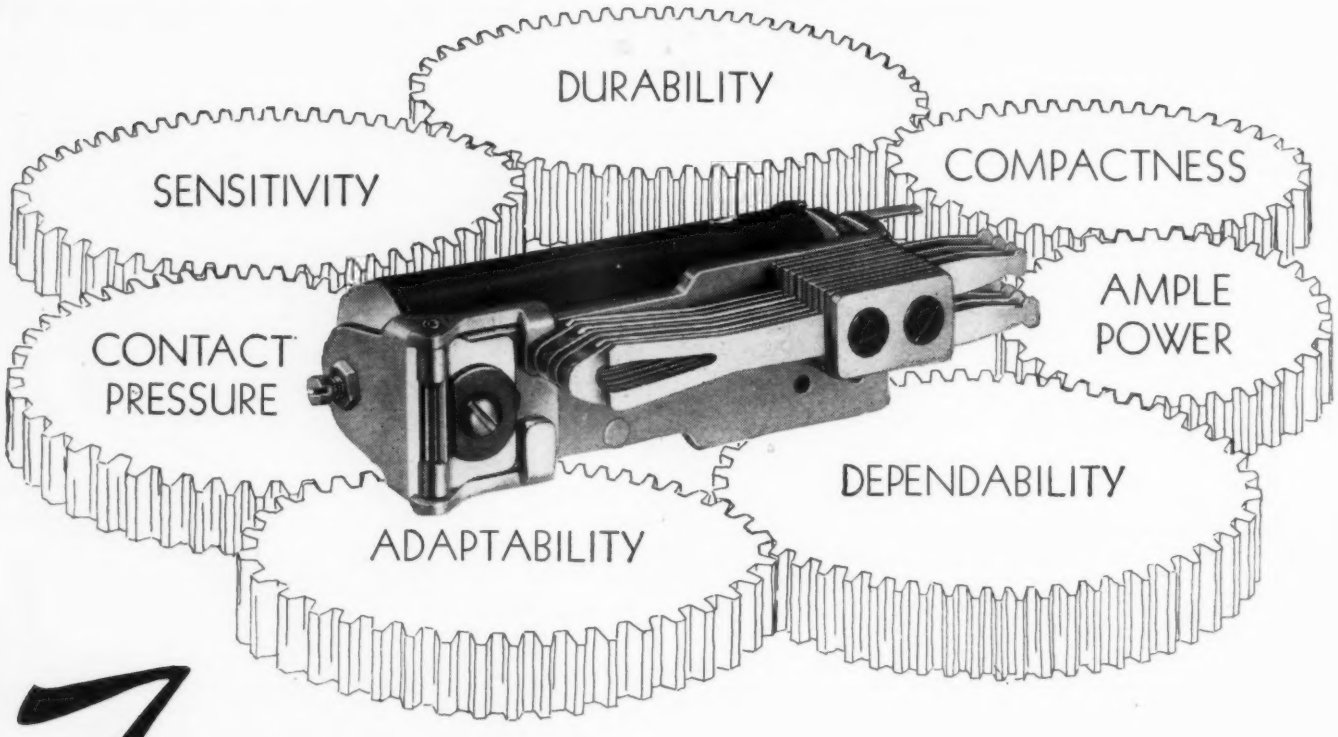


Marking time or "resting on laurels" *in no way* reflects Allied's engineering and business philosophy. A specific control does a good job . . . but can it be improved? Allied engineers and field staff check its working performance . . . seek possibilities to better or broaden its usefulness.

Thus refinements, revisions and modifications in basic types of relays come about—as in the three and four pole "DO" and the all-purpose double pole "BO" types described herein. Keeping pace with the constant engineering progress of manufacturers whose products require electrical control . . . anticipating their requirements . . . epitomizes Allied's philosophy. Let your control problems become our engineering projects.

ALLIED CONTROL COMPANY, INC.

GENERAL OFFICES: 2 East End Ave. (at 79th St.) New York 21, N. Y. *Factories:* New York City (2 East End Ave.)—Plantsville, Conn. *Chicago*—4321 Knox Avenue, Chicago 41, Illinois. *In California:* Allied Control Co. of California, Inc. 1633 South Hope St., Los Angeles 15, Calif.



7 *vital qualities* GEARED TOGETHER

IN THE NEW AUTOMATIC ELECTRIC CLASS "B" RELAY

• Check over one by one the qualities you want most in any relay. Here, in this new relay, you will find them all—combined to give outstanding performance in any electrical control application.

Sensitive enough to operate on minute current, the Class "B" has also the high contact pressure needed for perfect closure—

Compact enough for multiple mounting in small space, yet with ample power for operating up to 28 contact springs—

With inbuilt quality needed for long service under tough conditions, and the dependability provided by dual circuit paths through independent twin contacts—

It will pay you to get the full story on this remarkable new relay. It is one of the forty basic types described in Automatic Electric's catalog 4071-D. Write today for your copy.

ONLY THE CLASS "B" RELAY HAS ALL THESE DESIGN FEATURES:

***Twin Contacts*—providing dual circuit paths for maximum reliability.**

***Efficient Magnetic Circuit*—for sensitivity and high contact pressure.**

***Unique Armature Bearing*—for long wear under severe service conditions.**

***Compact Design*—for important savings in space and weight.**

***Versatility*—Available for coil voltages to 300 volts d-c and 230 volts a-c, and with contact capacities up to 28 springs; also with magnetic shielding cover if desired.**

Relays
AND OTHER CONTROL DEVICES
by AUTOMATIC ELECTRIC

AUTOMATIC ELECTRIC SALES CORPORATION
1033 West Van Buren Street • Chicago 7, Illinois

In Canada: Automatic Electric (Canada) Limited, Toronto

PARTS AND ASSEMBLIES FOR EVERY ELECTRICAL CONTROL NEED

LONG LIFE

FOR SMALL BLOWER REQUIREMENTS

Illustrated is A.C. Model 3546, capable of approximately 60 c.f.m. Diameter of Micromotor on this unit is 3⅝".

REDMOND

THE BIGGEST NAME IN SMALL MOTORS

Redmond

MICROMOTOR BLOWER UNITS

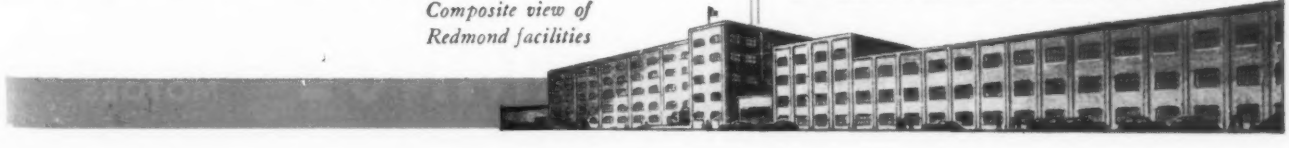
HERE is a good little blower—and it has a motor that will keep it running smoothly for thousands of hours on continuous duty. Its excellent reputation for long life is backed up by years of engineering experience in working out a wide variety of applications. Redmond Micromotor Blower Units are built in single and dual types for Alternating Current operation with delivery from 40 to 120 cubic feet per minute. D.C. types are also available. *Write us today for complete information.*

Composite view of Redmond facilities

Redmond COMPANY, Inc.

OWOSSO, MICHIGAN, U. S. A.

MICROMOTORS ☆ DYNAMOTORS ☆ CONTROLLERS ☆ BLOWERS



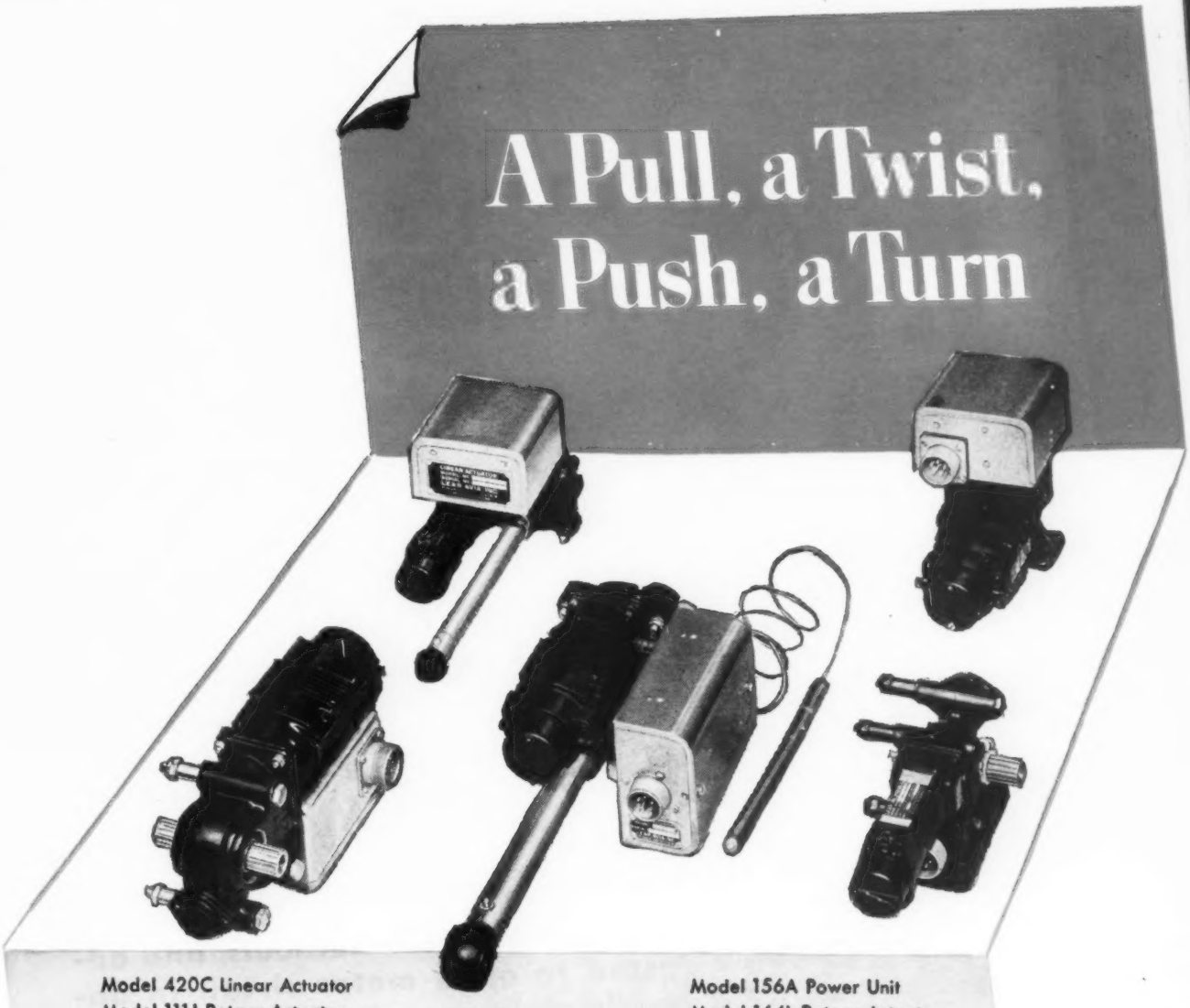
Expertly Balanced for TOP PERFORMANCE

DELCO APPLIANCE MOTORS are statically and dynamically balanced for smooth operation under all operating conditions. Exhaustive efforts are made in our testing laboratories through exacting checks with costly precision instruments to make these small motors star performers...economical to operate . . . enduring in service.

You will never find a use for one of these remarkable little motors as tough in its demands as the torturous tests which we give them to prove their stamina. Whatever your need in fractional horsepower, a Delco Appliance motor can be made to fit it. DELCO APPLIANCE DIVISION, General Motors Corporation, Rochester, N.Y.

General Motors **DELCO APPLIANCE** FRACTIONAL HORSEPOWER MOTORS

A Pull, a Twist, a Push, a Turn



Model 420C Linear Actuator
Model 111J Rotary Actuator

Model 400E Linear Actuator
(with temperature control)

Model 156A Power Unit
Model 164L Rotary Actuator

Whatever mechanical action is wanted — motion in a straight line — through an arc — or steady turning — there's a Lear unit to provide it.

These units are compact — fit into almost any available space. They are powered by Lear precision-built motors with the Fastop Clutch, so that they do not overrun and precise positioning is possible.

When advantageous, their motion can be transmitted around bends into out-of-the-way places through Lear Flexible Shafting.

Industry is going to find many needs for these capable units. You may already have a problem of motion which one of them would solve at a saving of time and money.

If you have, please write and let us know. While our engineers are applying these devices to war needs, they will be glad to discuss with you whatever problem you have.

LEAR,
Incorporated
Piqua, Ohio

formerly Lear Avia, Inc.

Lear INCORPORATED

LEAR, Incorporated
Dept. 81
Piqua, Ohio

Gentlemen:

Please send me your free booklet showing Lear equipment and its many applications.

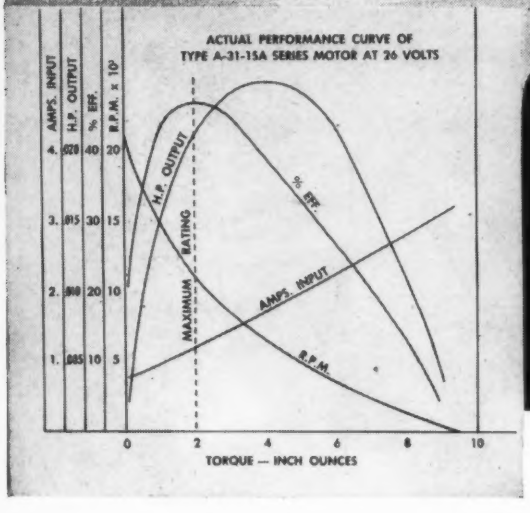
Name_____

Address_____

City_____

State_____

This Type A-31-1SA Oster Motor operates dependably in many aircraft applications.



Now available . . . an Oster Motor

REG. U. S. PAT. OFF.

thermostatically protected *

to prevent motor burnouts, and adjusted to open motor circuit in approximately one minute under locked rotor conditions at rated voltage . . .

Here is another Oster motor with features that make it ideal for many applications in aircraft. The thermostatic control prolongs the life of the motor by preventing burnouts. Its weight (11 ounces) and body size (1½ x 3″) are reduced to a minimum without impairing efficiency. The performance record is backed by 16 years of engineering experience in the fractional-horsepower field.

You can depend on it to deliver creditable results that add to your own reputation for selecting sources wisely. Let us help you fit this or other Oster motors to your requirements. Write for further details.

IN 1955 — YOU'LL WISH YOU HAD PURCHASED "EXTRA" BONDS IN 1945 — BUY YOURS TODAY!

M-23

Rating of type A-31-1SA Motor

Horsepower — 1/50 intermittent.
Speed — 10,000 rpm.
Voltage — 26 D.C.
Winding — series.
Rotation — clockwise viewing rabbet end.
Duty Cycle — 15 min. on — 30 min. off.

Features of type A-31-1SA Motor

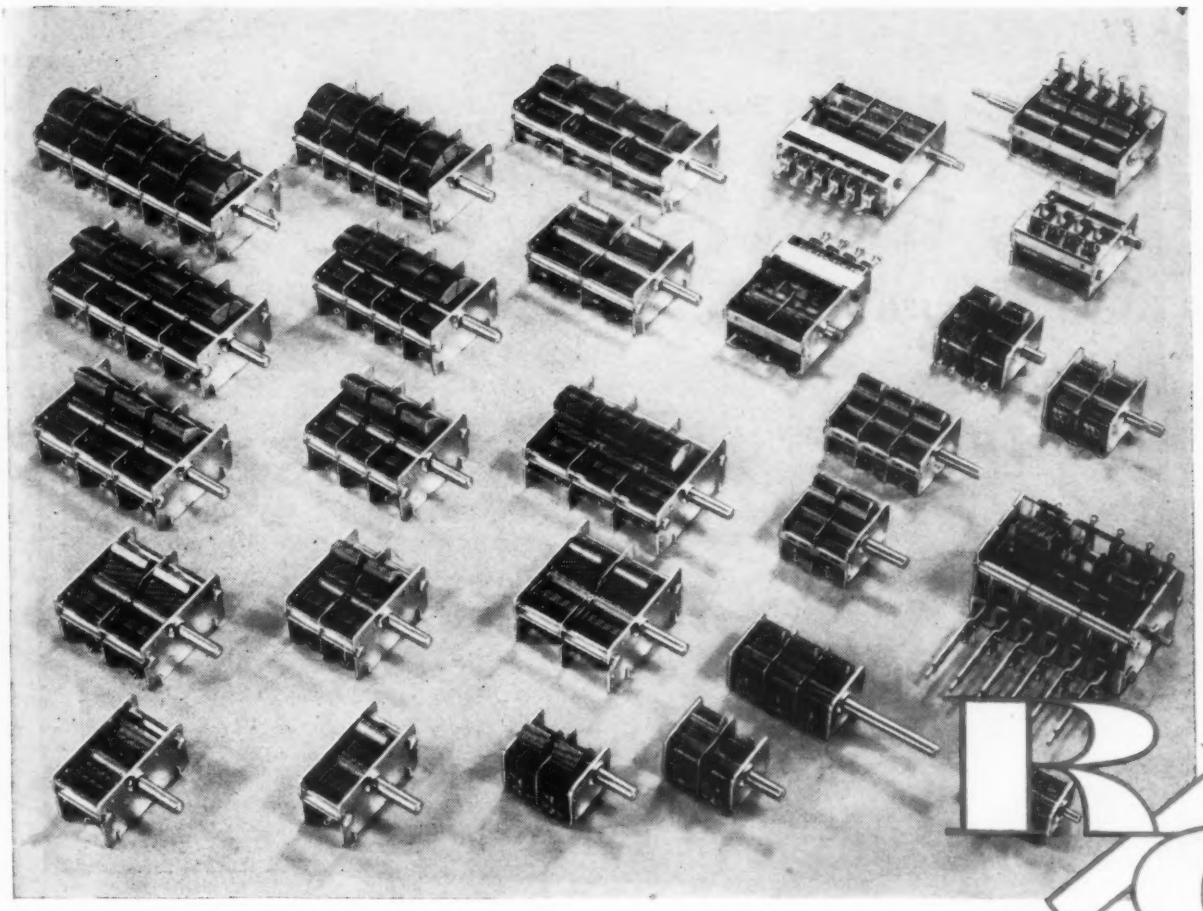
Housing — die cast aluminum, totally enclosed.
Finish — black anodized.
Weight — 11 ounces.
Bearings — High quality single shielded ball bearings, lubricated with grease suited for any specific application. Bearing housings fitted with steel inserts.
Brushes — High grade metal graphite of ample size to assure unusually long brush life.
Thermostatic Protector — Prevents motor burnouts, adjusted to open motor circuit in approximately one minute under locked rotor conditions at rated voltage.
Temperature Rise — 55° C. maximum frame temperature rise at rated load.
Mounting—Standard ¾″ dia. Air Corps rabbet.
Modifications—Special shaft extensions, mounting arrangements, leads, etc. Information regarding motors for specific applications furnished upon request.

Suitable for various aircraft applications.

All ratings and data are approximate.

John Oster Manufacturing Co.

DEPARTMENT E-23 • RACINE, WISCONSIN



WHEN YOU GET TO THE *VARIABLE CAPACITOR*

NO component today is more important than the tuning unit. On it, to a large extent depends your over-all design and, consequently, the essential sales features of your product.

And whether your call is for a variable capacitor or a complex tuning assembly, R/C can offer more and better informed help than you can obtain from any other source. Here you will find an unsurpassed wealth of specialized tuning unit experience at your disposal—dozens of standard types from which to choose—and facilities for the design, engineering and quantity production of any special unit that may be required.

RADIO CONDENSER CO.

CAMDEN, N. J.

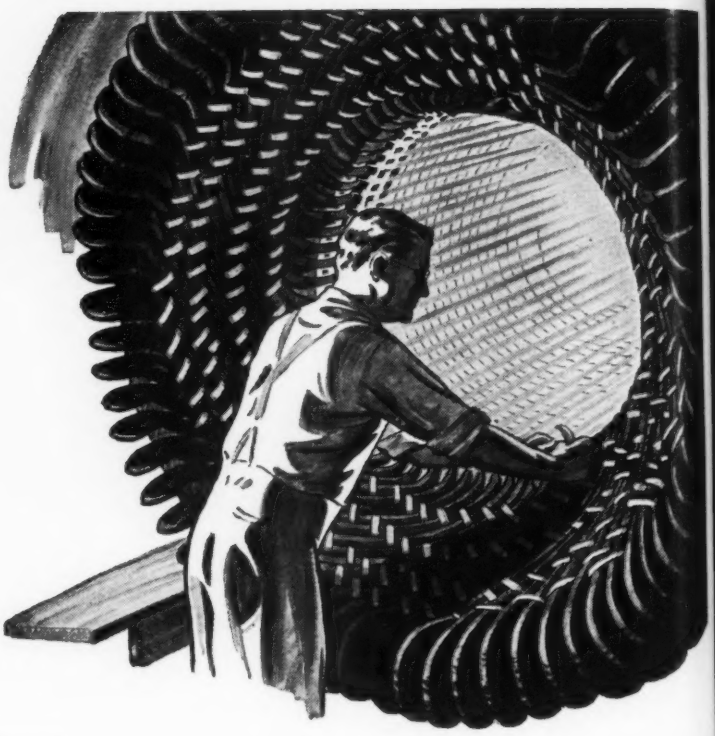
RADIO CONDENSER COMPANY LTD., TORONTO, CANADA

(Suppliers to Set Manufacturers)

WHAT NEXT

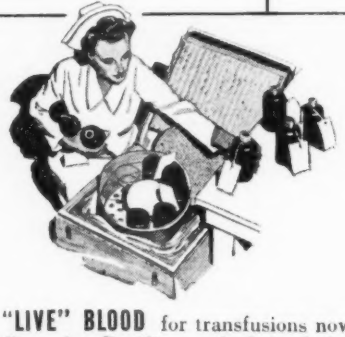
WILL THEY DO WITH THESE

FIBERS OF GLASS?

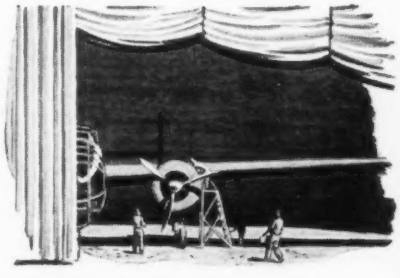


DELICATE RELAYS and switches in many of the Nation's busy telephone exchanges are kept free of harmful dust, dirt and lint with *Fiberglas DUST-STOP* Air Filters* installed in the air conditioning systems. Adhesive-coated glass fibers account for the great efficiency of these popular replacement-type filters—having great surface area for catching dirt—providing clean air at low cost for forced-warm-air-heated homes as well as industry.

IN 37,000 HP TURBO-GENERATORS—as in midget, pitch-change motors for aircraft propellers—electrical engineers are utilizing the unique properties of *Fiberglas** Textiles to provide better *electrical insulation.* Woven from strong yarns made of fine filaments of glass, these Fiberglas tapes and cloths (and braided sleevings) are highly resistant to heat, moisture, oil and corrosive vapors. When used with suitable impregnants they make possible better performance and longer life for hard-pressed, vital-to-victory electrical equipment.



"LIVE" BLOOD for transfusions now flies the Pacific—packed in lightweight plywood "iceboxes" insulated with fleecy Fiberglas. With a single loading of ice, safe temperatures are maintained for more than 60 hours! *Fiberglas Thermal Insulation* helps make this possible due to its low heat conductivity and light weight—two of many properties that have made it "first choice" for insulating aircraft, railway cars, trucks, buses and ships.



CURTAINS OF FIBERGLAS CLOTH, coated with specified synthetics, serve as weatherproof doors and side walls of demountable repair-shop hangars at advance aircraft bases, close to the enemy. The Fiberglas textile base, being glass, doesn't stretch or shrink; is unaffected by temperature changes; will not rot, decay, mildew. Wartime uses—such as water tanks, flexible ducts, battery covers, etc.—suggest innumerable peacetime applications for coated Fiberglas cloth.

Fiberglas, in its many forms, is today contributing to the production of better materials of war. New uses are constantly being found for this versatile basic material. Some of these developments, now closely guarded military secrets, promise even more exciting advantages to users, even greater benefits to hundreds of industries now served by Fiberglas. For information and application assistance, write *Owens-Corning Fiberglas Corp., 1807 Nicholas Building, Toledo 1, Ohio.*

In Canada, Fiberglas Canada Ltd., Oshawa, Ontario.

Buy War Bonds for Keeps!

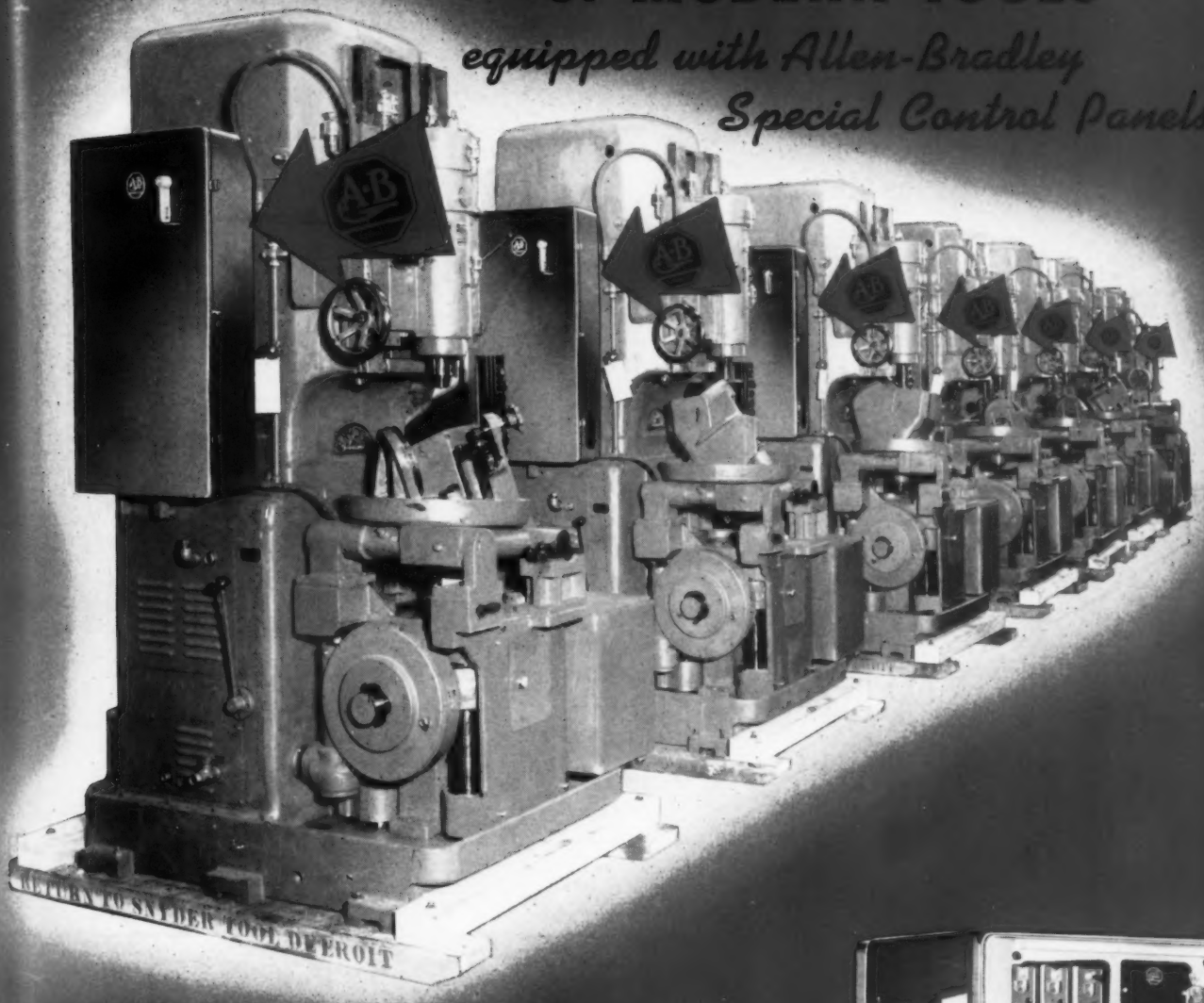
FIBERGLAS

ARMY E NAVY

*T. M. Reg. U. S. Pat. Off.

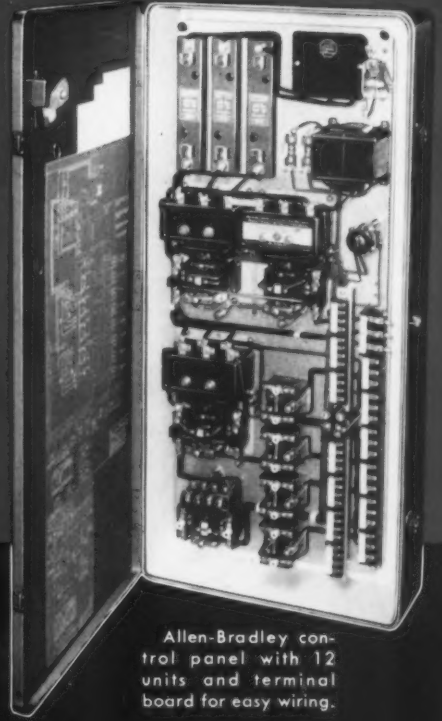
ANOTHER SHIPMENT of MODERN TOOLS

equipped with Allen-Bradley Special Control Panels



THIS shipment of Snyder profile milling machines shows how leading machinery manufacturers are standardizing on Allen-Bradley special control panels. Today, all control units of a modern machine tool, such as contactors, relays, and disconnect units, are assembled on one panel in a neat steel cabinet. Push buttons are then mounted to be convenient for the operator, while limit switches are installed where required to govern the sequence operation of the machine.

Your machines can be streamlined . . . and performance often improved . . . with A-B special control panels. An Allen-Bradley engineer will gladly study your equipment and discuss a special panel layout to fit your needs. There is no obligation.



Allen-Bradley control panel with 12 units and terminal board for easy wiring.

A-B

ALLEN-BRADLEY

SOLENOID MOTOR CONTROLS FOR ALL INDUSTRIES

QUALITY

Are you familiar with Allen-Bradley Precision Limit Switches . . . those rugged but highly sensitive units for precision control of sequence operations? Send for Bulletin 802.

Is your File up-to-date on Limit Switch Developments?

Limit switches are so important in automatic motor control that it takes 72 pages in the Allen-Bradley catalog to list all the latest developments in A-B limit switches. An additional special 24-page technical bulletin tells how and how-not to install them.

Let us send you this 96-page limit switch catalog for your file. It is full of valuable suggestions, diagrams, and pictures . . . just what every machinery engineer needs to solve unusual motor control problems. And for the tough jobs call your nearest Allen-Bradley engineer. There is no obligation.

Allen-Bradley Co., 1316 S. Second St.
Milwaukee 4, Wisconsin

A-B Quality

ALLEN-BRADLEY

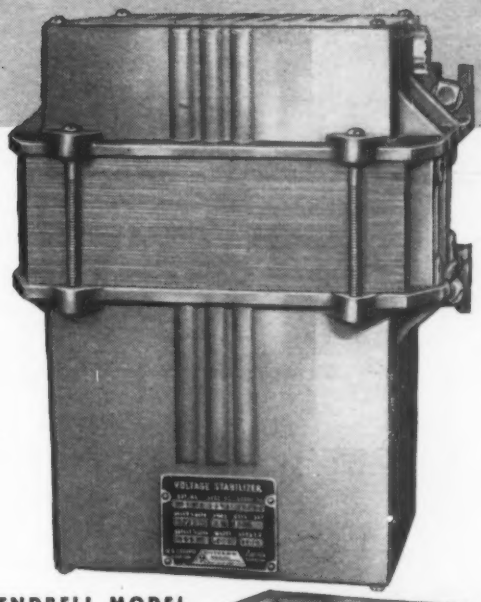
LIMIT SWITCHES FOR EVERY SERVICE

QUALITY

RAYTHEON VOLTAGE STABILIZERS

Keep Varying Input Voltages Uniform

at ±½% of 1%



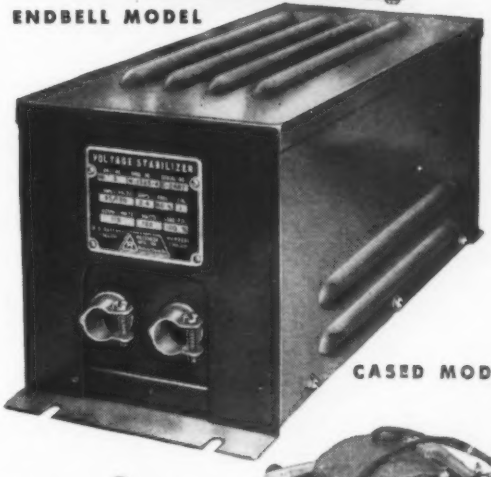
ENDBELL MODEL

Built into new equipment or incorporated into equipment already in use, Raytheon Voltage Stabilizers improve the operation of electrical equipment by stabilizing varying input voltages to ±½% of 1% within 2 cycles.

Because they have no moving parts . . . nothing that wears out, they require no adjustments or maintenance. Simply hook them up and Raytheon Voltage Stabilizers will give years of trouble-free service.

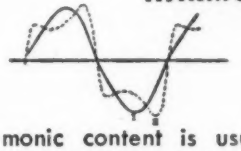
Many models and ratings are available for practically every application requiring uniform voltage. All stabilize voltages at any load within ratings to ±½%.

Standard Raytheon Voltage Stabilizers may be had for controlling A. C. input variation of 95 to 130 volts or 190 to 260 volts. Write for bulletin DL48-537. It gives dimensions, operating characteristics and other important data.



CASED MODEL

HARMONIC CONTENT



The high magnetic density in one of the transformers introduces harmonics in the output voltage wave. The actual harmonic content is usually unimportant except when instruments are being calibrated.

The output wave form is illustrated in the accompanying figure and table.

ANALYSIS OF OUTPUT VOLTAGE

Curve No.	Input Volts	Percentage Harmonic 1st	3rd	5th	7th
I	95	99.4	7.1	2.2	Trace
II	131	96.8	24.0	7.0	3.6

UNCASED MODEL

Tune in the Raytheon radio program: "MEET YOUR NAVY," every Saturday night on the Blue Network. Consult your local newspaper for time and station

RAYTHEON MANUFACTURING COMPANY

Electrical Equipment Division

190 WILLOW STREET, WALTHAM, MASS.

The coveted Army-Navy "E," for Excellence in the manufacture of war equipment and tubes, flies over all four Raytheon Plants where over 16,000 men and women are producing for VICTORY.

Devoted to research and manufacture of complete electronic equipment; receiving, transmitting and hearing aid tubes; transformers; and voltage stabilizers.

STUPAKOFF

Engineered Ceramic Insulators
FOR ELECTRICAL APPLIANCES

STUPAKOFF Insulators—engineered to meet the rigid requirements of mass production methods—offer profitable advantages to manufacturers in the appliance industry.

They are mechanically strong to withstand manufacturing operations—dimensionally accurate for quick assembly—always uniform, keeping production lines flowing smoothly. Made of ceramic—inorganic, dense, non-hygroscopic materials—they provide maximum electrical protection.

Stupakoff facilities are geared to provide an unending flow of precision insulators to builders of electrical and electronic products. Many styles of insulators are stocked for immediate shipment.

Write us about your requirements. A competent and experienced staff will work with you in the development of engineered ceramics for your products.

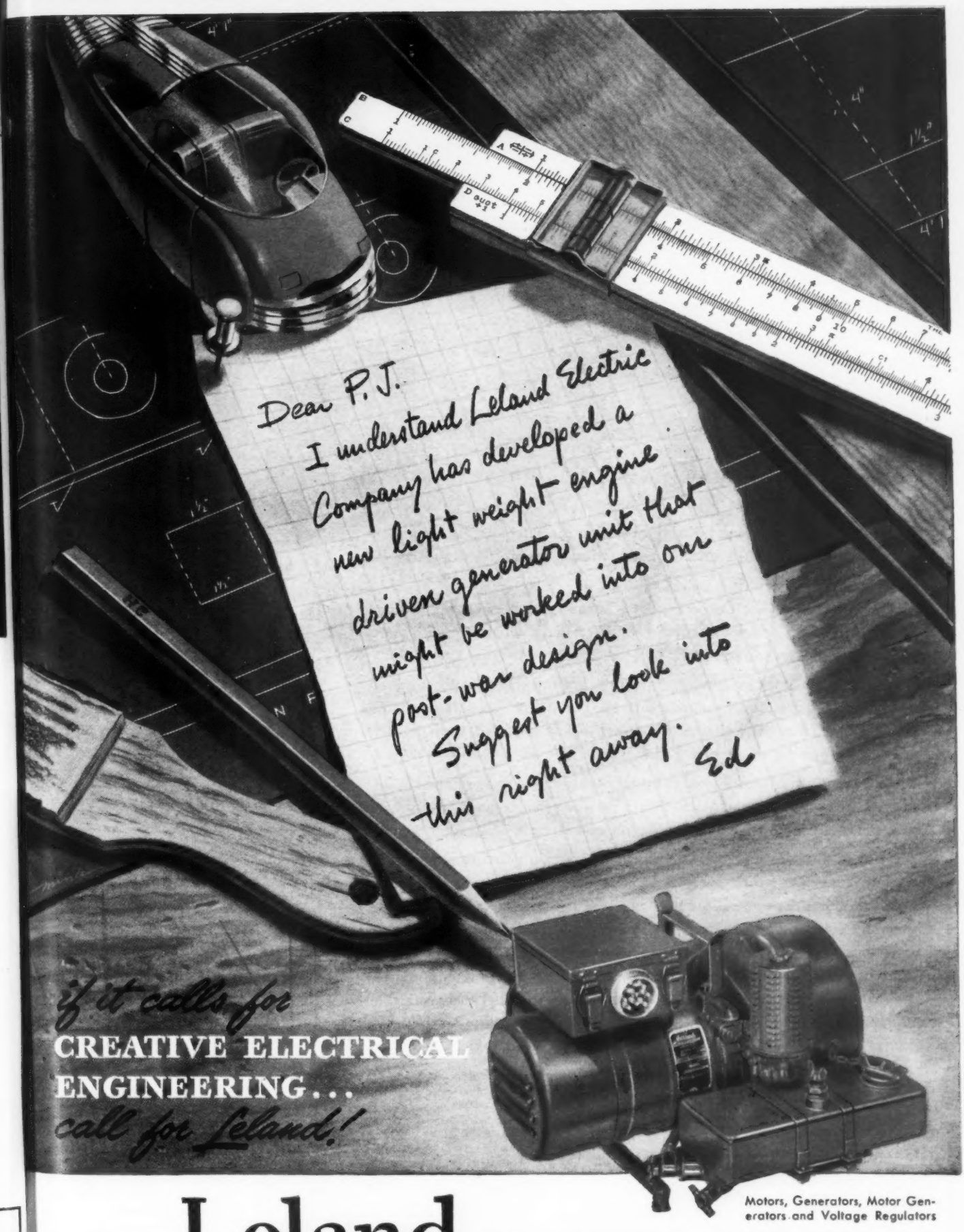
BUY MORE WAR BONDS

ARMY E NAVY "FOR GREAT ACHIEVEMENT"

STUPAKOFF CERAMIC AND MANUFACTURING CO., LATROBE, PA.

Ceramics for the World of Electronics

RMA MEMBER RADIO MANUFACTURERS ASSOCIATION


Dear P.J.
I understand Leland Electric Company has developed a new light weight engine driven generator unit that might be worked into our post-war design.
Suggest you look into this right away.
Ed
if it calls for
CREATIVE ELECTRICAL ENGINEERING...
call for Leland!

Motors, Generators, Motor Generators and Voltage Regulators

THE Leland ELECTRIC COMPANY

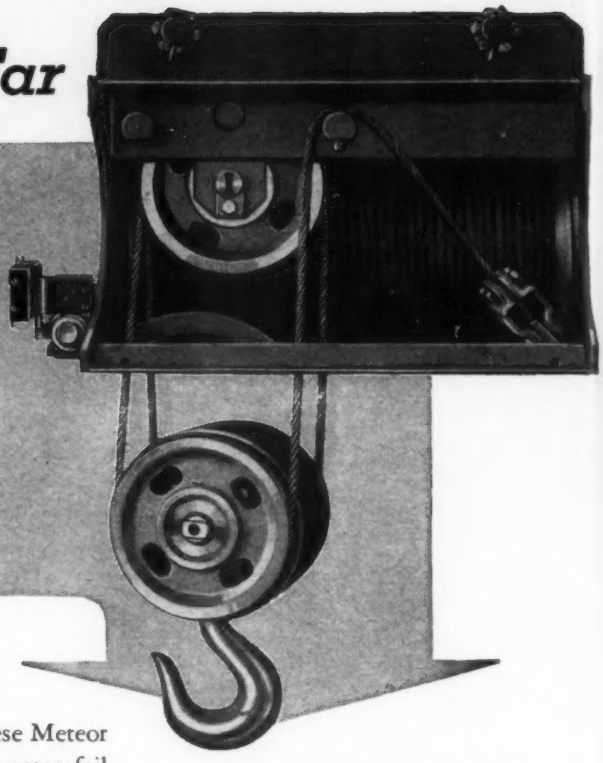
DAYTON, OHIO • IN CANADA, LELAND ELECTRIC CANADA, LTD.... GUELPH, ONTARIO

This Hoist Can't Go Too Far

MICRO SWITCH

SNAP-ACTION

Takes Care of That



There's a limit to how far a hoisting operation can safely go. These Meteor Electric Hoists protect themselves automatically, should the operator fail to stop the hoist in time.

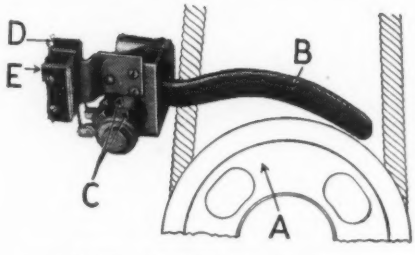
Chisholm-Moore Hoist Corporation of Tonawanda, New York, use two Micro Switch snap-action switches in the safety limit which make it impossible to jam the lower hook block into the drum.

When the hook block reaches its uppermost limit of travel, it raises a limit lever. This is mechanically connected to the two Micro Switch snap-action switches which break the pilot circuit, stop the flow of current to the motor, and apply a quick-acting motor brake.

These streamlined Meteor Electric Hoists, backed by 50 years of hoist building experience, make use of Micro Switch products in a design which utilizes all space to advantage . . . avoids all cumbersome bulk and excess weight.

This use of these dependable, long-lived, snap-action switches is typical of the increasing use which every branch of industry is finding for Micro Switch products. In some applications their sensitivity, the small operating force and small travel required to operate them are important. In other applications the ability of these tiny switches to handle substantial amounts of power at line voltages without the use of relays is of prime importance. Their millions of accurate repeat operations make these switches valuable components of the highest type of industrial products.

Here is How It Works



Two roller lever actuated switches are used.

When hook block "A" reaches the uppermost point of travel it strikes lever "B" which is connected by a shaft to cams "C". One cam is set slightly ahead of the other in order that one switch may be operated first.

Operation of switch "D" opens the pilot circuit of the hoisting motor. Should the gear train continue to move in excess of a predetermined amount, the second cam operates switch "E" which closes the lowering pilot circuit, momentarily reversing the motor. This lowering circuit is again opened as soon as the hook is lowered a small amount.

DO YOU NEED A SWITCH TO...

control temperatures, help to package products, bottle fluids, record airplane flights, make change, dispense drinks, heat water, control electronic tubes, or steer ships? Micro Switch snap-action switches successfully control many such operations . . . and thousands more. Micro Switch engineers, experienced in the application of millions of these precise, snap-action switches to products for both war and peace, will be glad to show you how they can add long life and reliability to your product at lower cost. Write for the Micro Switch Handbook-Catalog today.

LET'S ALL BACK THE ATTACK *BUY EXTRA WAR BONDS*

© First Industrial Corporation

MICRO MS SWITCH

TRADE MARK

A DIVISION OF FIRST INDUSTRIAL CORPORATION

Freeport, Illinois, U. S. A. Sales Offices in Principal Cities

The basic switch is a thumb-size, feather-light, plastic enclosed, precision, snap-action switch, underwriters' listed and rated at 1200 V. A., at 125 to 460 volts a.c. Capacity on d.c. depends on load characteristics. Accurate reproducibility of performance is maintained over millions of operations. Basic switches of different characteristics are combined with various actuators and metal housings to meet a wide range of requirements.

THIS conversation might easily occur at our reception desk because here under one roof and management we produce both small motors and molded plastics in large quantities for use in widely different products.

YES, YOU CAN BUY *BOTH* AT GENERAL INDUSTRIES

Take small motors. We've built *Smooth Power* units for many years for our own line of velvety operating recorders, record-changers and turntables. We supply standard or designed-to-order *Smooth Power* drives and assemblies for automotive devices, controls and other small electric products. Our customers include leading manufacturers in a wide range of industries.

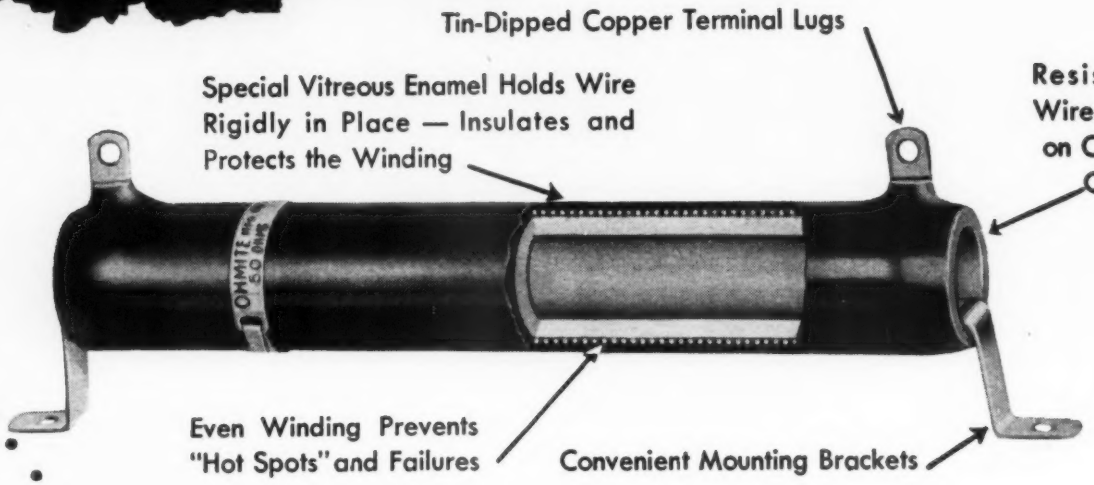
Now about molded plastic parts. We have the equipment for small and large work in any quantities. Our engineers, mold makers and machine operators have the combined "know-how" to deliver better plastic parts quicker and at prices in line with our established high quality. If you visit our factory (and you'll be welcome) you'll be amazed at the diversity of our work and at the length and quality of our customer list.

THE GENERAL INDUSTRIES COMPANY
ELYRIA, OHIO

ARMY E NAVY

Yes, you can buy both small motors and molded plastics for your postwar products from General Industries. We suggest a general discussion now, to be followed by details when our war work has been finished. It will be appreciated if you will address the specific division . . . *motors* or *molded plastics*.

Why OHMITE Resistors PERFORM SO DEPENDABLY

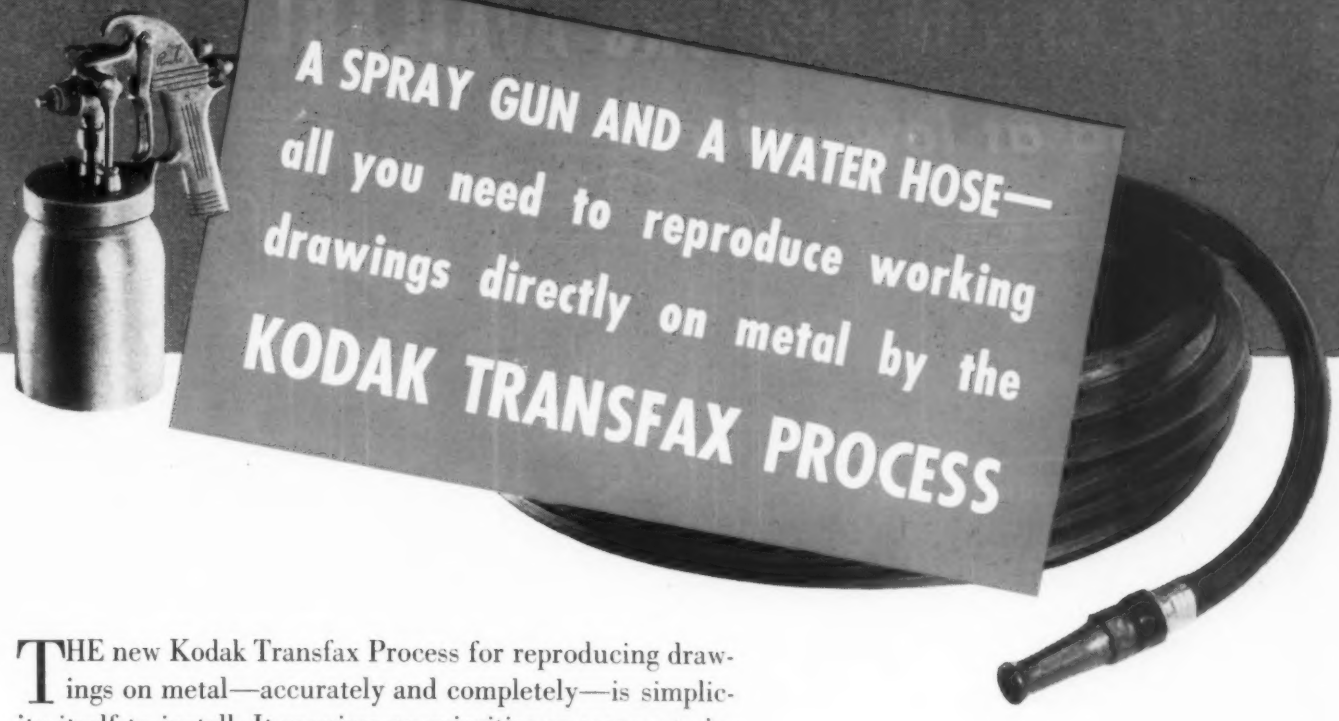

Tin-Dipped Copper Terminal Lugs
Special Vitreous Enamel Holds Wire Rigidly in Place — Insulates and Protects the Winding
Resistance Wire Wound on Ceramic Core
Even Winding Prevents "Hot Spots" and Failures
Convenient Mounting Brackets

Here you see a few of the important features that insure long life and trouble-free service in every Ohmite Resistor. In the lug type illustrated above, the resistance wire is both mechanically locked and brazed to copper terminal lugs to assure perfect electrical connection. Time-proved Ohmite vitreous enamel construction dissipates heat rapidly . . . withstands humidity. Today, Ohmite Resistors are extensively used in the Armed Forces, Industry, Communications, Research. *Made in a wide range of types and sizes* in stock and special units for every need. Consult Ohmite engineers on your resistor problem.

OHMITE MANUFACTURING COMPANY
4820 FLOURNOY ST., CHICAGO 44, U. S. A.

Write on company letterhead for Industrial Catalog and Engineering Manual No. 40. Gives helpful information on resistors, rheostats, chokes, tap switches.

Be Right with OHMITE
RHEOSTATS • RESISTORS • TAP SWITCHES



A SPRAY GUN AND A WATER HOSE— all you need to reproduce working drawings directly on metal by the KODAK TRANSFAX PROCESS

THE new Kodak Transfax Process for reproducing drawings on metal—accurately and completely—is simplicity itself to install. It requires no priorities or scarce equipment, no special training of workers—it is handled in ordinary light, with just a regular spray gun and a water hose . . .

And in operation, five easy steps—easy even for beginners—complete the process:

1 Using an ordinary spray gun, coat the metal sheet or other nonporous material with Transfax Primer.

2 Spray with quick-drying Transfax Spray, for a light-sensitive surface that reproduces any drawing . . .

3 Place drawing in contact with the sensitized surface . . . expose briefly to arc or mercury vapor light.

4 Rinse, first with weak ammonia solution . . . then hose with water . . . and the drawing is on metal.

5 After spraying on an overcoat of Transfax Primer, your reproduction is ready for fabrication.

The TRANSFAX PROCESS, taking hours less than laborious scribing, proves itself the fastest of all aids to template-making . . . transfers full-size working drawings directly to template material . . . quickly . . . accurately.

Efficient, economical, the Kodak TRANSFAX PROCESS speeds production in many ways—especially where layouts are complex . . . where instructions must go on templates . . . where many reproductions are needed . . . where different parts can be laid out on one sheet. For full information write: Eastman Kodak Company, Rochester 4, N. Y.

ANOTHER METHOD, reproducing working drawings directly on template material, is the KODAK LINAGRAPH PROCESS. Light-sensitive Kodak Linagraph Transfer Paper, laminated to the template sheet, permits "printing" the layout by either contact or projection. In the contact method, line-for-line duplication is identical in size with the original drawing. In the projection method variation in scale is possible . . . valuable in the making of experimental models. With either method, reproduction is photographically accurate and complete.

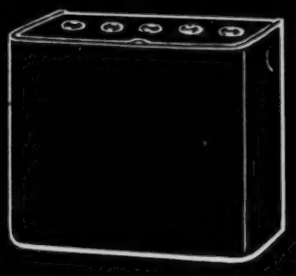
KODAK TRANSFAX PROCESS

Saves Time . . . Ends Error . . . Speeds Production

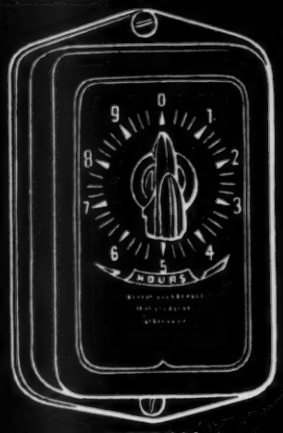
Kodak

TELECHRON MOTORS AVAILABLE NOW*

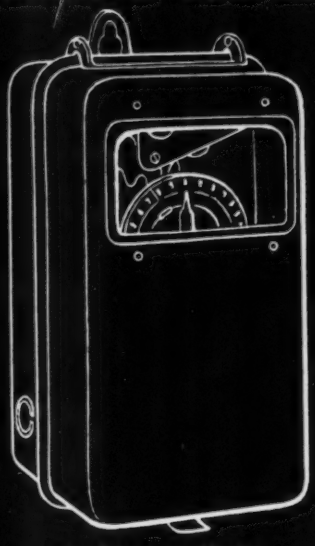
...and at low prices!



STOKER CONTROLS

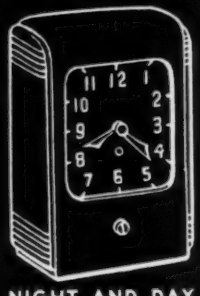


INTERVAL TIMER SWITCHES



GENERAL PURPOSE 24-HOUR TIME SWITCHES

RANGE TIMERS



NIGHT AND DAY THERMOSTAT SWITCHES

*At present, AA5 priority required

THE things engineers demand in a time switch are absolute accuracy, dependability and long life. You can *guarantee* these advantages if your switch has a Telechron synchronous motor.

Telechron motors, operating in perfect synchronism with all commercial A C frequencies, are 100% accurate. They're self-starting, reach rated speed almost instantly, take little power. They're light and compact, yet develop many times the power of any spring-driven clock mechanism. Precision building and an exclusive lubrication system assure long, trouble-free life.

Their advantages are the result of Telechron's 25 years' experience in making synchronous motors . . . *and of adapting them to the most exacting demands of timing, switching and control instruments.*

Our pioneering experience in *application engineering* is at the service of time switch manufacturers who want a better motor for their post-war products. There's no obligation. Just address Motor Advisory Service, Dept. D.

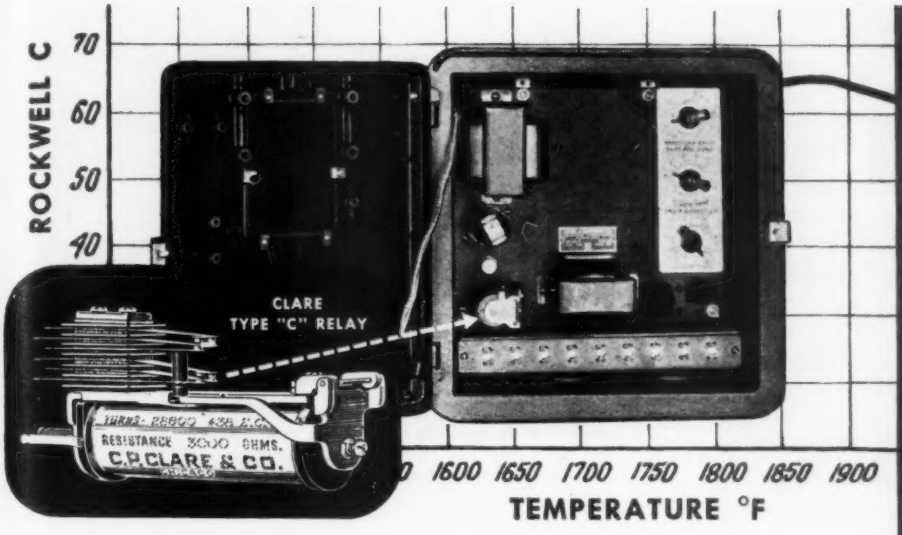
Here's News for Time Switch Makers

Telechron

REG. U. S. PAT. OFF.

WARREN TELECHRON COMPANY • ASHLAND, MASS.

Makers of Telechron Electric Clocks and Synchronous Motors



CLARE *"Custom-Built"* RELAYS

Help Micromax Electric Controls Maintain Precise Furnace Temperatures

Clare Type "C" Relay is used to regulate the flow of electric energy in the Micromax Electric Control. This product of Leeds & Northrup Company of Philadelphia, Pa., proportions the duration of "on-heat" to "off-heat" which provides the precise, even heat control demanded in the operation of electric furnaces, ovens and baths.

To maintain precise temperature the Micromax Electric Control employs two electrical balances: one to measure temperature; the other to carry out control action. A knob on the control instrument is set to prevent temperature from overshooting the control point . . . especially important when a furnace is being brought to temperature under a full heat-head.

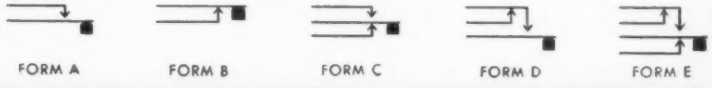
Whenever the temperature leaves the control point, a Clare Relay modifies the on-off action of the contactor to readjust heat-input and restores balance in the control circuit.

Leeds & Northrup engineers chose a Clare Relay for this important part of their control unit because the flexibility of Clare "custom-building" gave them the sensitive, positive action, the absolute dependability, and the accuracy to meet most exactly their requirements.

This use of Clare "Custom-Built" Relays to operate delicate controls is typical of the way in which engineers and designers everywhere are finding Clare the exact relay for the unusual application. The Type "C" Relay offers you a design that permits a wide range of contact ratings, the choice of five different contact forms or any combination of them, either flat or hemispherical contacts of rare metals or special alloys, coil windings to match the circuit and application.

What is your problem? Let Clare "custom-build" a relay to your specifications. Investigate the possibilities for higher efficiency and reduced relay costs. Send for the Clare catalog and data book. Address C. P. Clare & Co., 4719 Sunnyside Avenue, Chicago 30, Illinois. Sales engineers in all principal cities. Cable address: CLARELAY.

Contact springs employing any of these forms can be furnished.



High voltage pile-up insulation withstands heavy break-down tests.

Contacts of rare metals and special alloys, welded to nickel silver springs.

Spring bushing insulators made by a patented process from Bakelite rod.

Double arm armature, stainless steel shaft in brass yoke can be furnished.

CLARE RELAYS

"Custom-Built" Multiple Contact Relays for Electrical, Electronic and Industrial Use

Out of wartime crucibles have come many by-products. Bimetals—developed for war needs—but of profound value in peacetime pursuits.

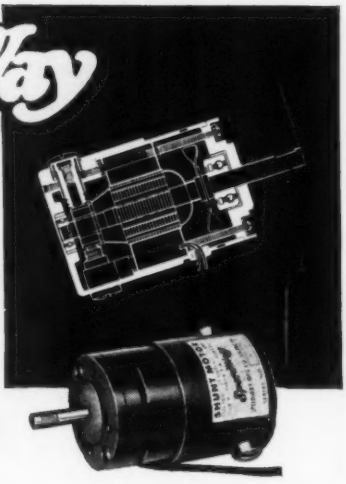
By new equipment and improved methods, Chace has vastly expanded its facilities for bigger production and faster delivery.

Today, this greater capacity and quickened service is being made available for the postwar demand for Chace Thermostatic Bimetals. To help in the production of such peacetime products as require dependable actuating elements for temperature responsive devices.

W.M. CHACE CO.
Manufacturers of
Thermostatic Bimetals and Special Alloys
1607 BEARD AVE • DETROIT 9, MICH.

CHACE BIMETALS — **35 DISTINCT TYPES** ★ SOLD IN SHEETS, STRIPS and FINISHED FORMS

SpeedWay
STANDARDIZED *Special* MOTORS *and* GEAR MOTORS



As a result of 30 years' specialization in the design and manufacture of special motors and gear motors of from 1/3000 to 1/3 h.p., SpeedWay has developed not only a vast store of "know how," but innumerable standardized units which can be assembled and wound in varying combinations to give shaded pole, shunt wound or series wound motors, engineered to exactly meet specified requirements of output, torque, space, speed and even cost.

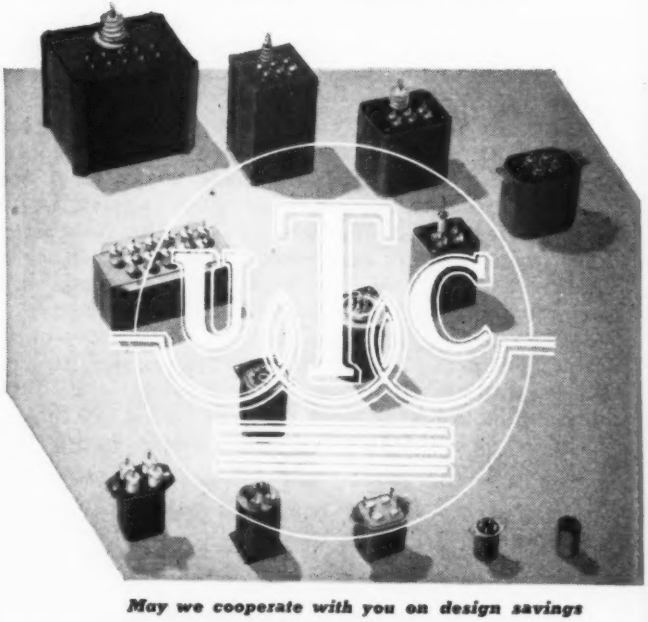
With these standardized parts and units, augmented by over 3000 different gear combinations, SpeedWay can often supply highly special motors and gear motors at standard motor prices.

If you have a war or post-war motor problem, send for the SpeedWay Motor Catalog.

Sample Motors of types now in production delivered promptly

SPEEDWAY MFG. CO.
1846 South Laramie Avenue — Cicero 50, Illinois

HERMETIC SEALED TRANSFORMERS
a type for every requirement



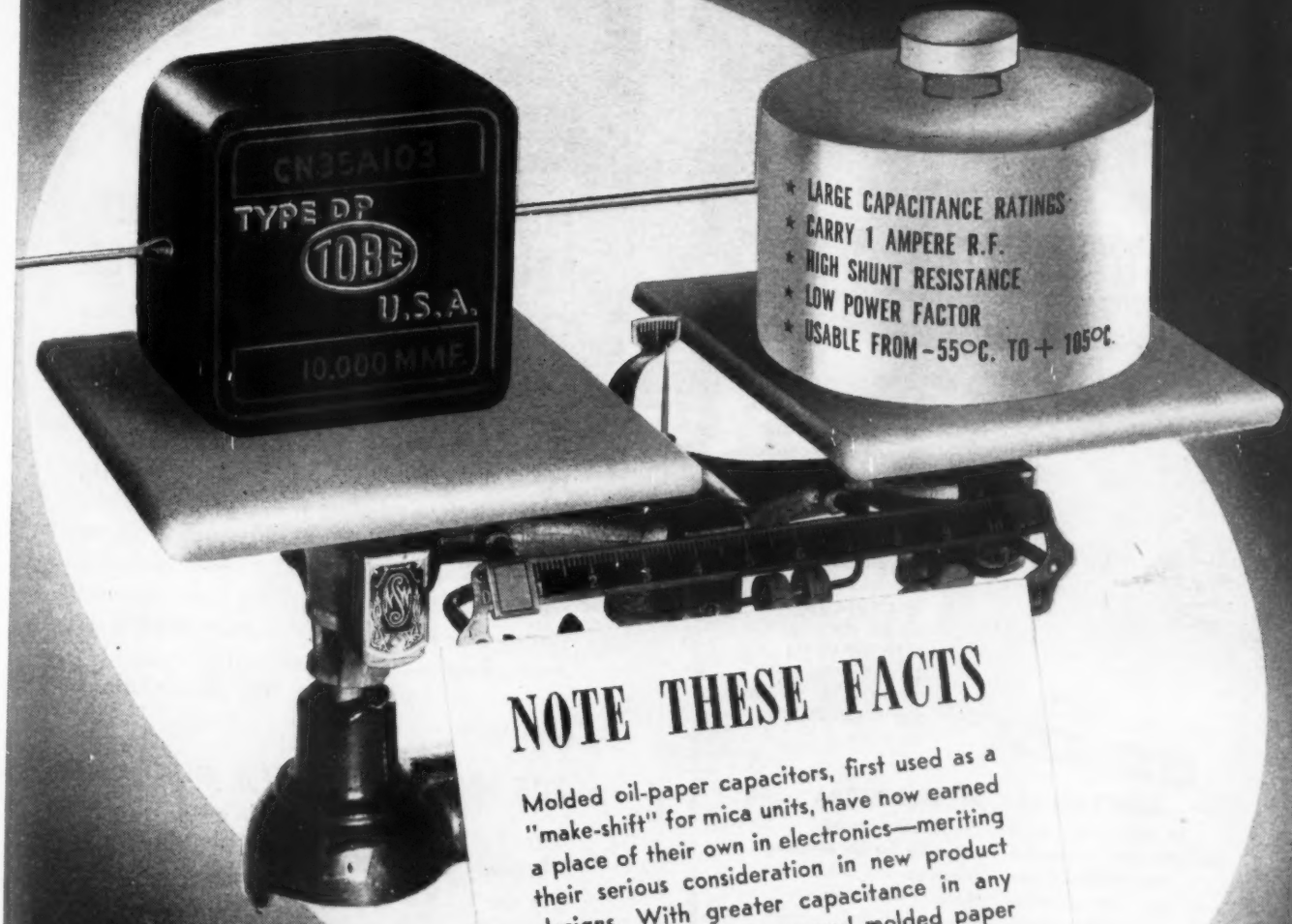
May we cooperate with you on design savings for your application... war or post war

ARMY-NAVY E — ALL PLANTS

United Transformer Corp.
150 VARICK STREET — NEW YORK 13, N. Y.
EXPORT DIVISION 13 EAST 40th STREET, NEW YORK 16, N. Y. — CABLES: ARLAB

Weigh the Advantages

of MOLDED OIL PAPER CAPACITORS



NOTE THESE FACTS

Molded oil-paper capacitors, first used as a "make-shift" for mica units, have now earned a place of their own in electronics—meriting their serious consideration in new product designs. With greater capacitance in any case size, properly processed molded paper capacitors have extremely low series resistance and can carry relatively large R.F. currents. Their high shunt resistance, maintained thru the moisture-proof sealing of all units, suits them to A.F. applications at all usual plate voltages.

CAPACITANCES: 1000 to 50000 mmfd.
WORKING VOLTAGES: 120 to 800 v.d-c
SIZES: CN20 and CN35

TOBE DEUTSCHMANN CORP.
TOBE
CANTON · MASSACHUSETTS

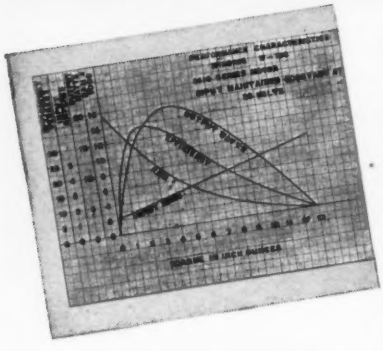
FIELD OFFICES IN NEW YORK CITY • CHICAGO • DETROIT • GLENDALE, CALIFORNIA

MOTOR DATA
No. 125

EICOR

1600 FRAME MOTOR

Torque 4.5 in. oz. at 5800 RPM



The power output of this precision motor is exceptionally high in proportion to its light weight and small size. Originally developed for numerous aircraft and portable applications, the characteristics of its performance can readily be modified for a variety of new uses.

FEATURES

ELECTRICAL

Series or shunt wound
Unidirectional or reversible
High starting torque
Low starting current
Low RF interference
Armature and field windings
Varnish impregnated and baked

MECHANICAL

Completely enclosed
Adaptable for any mounting
Laminated field poles
Stainless steel shaft
Two precision ball bearings
Mica insulated commutator
Permanent end play adjustment

1600 Frame Motors		Series	Shunt
Watts Output, Int.	(max.)	22	
Watts Output, Con.	(max.)		5
Torque at 8500 RPM	(in. oz.)	3	
Torque at 5800 RPM	(in. oz.)	4.5	1
Lock Torque	(in. oz.)	12	3
Volts Input	(min.)	5	5
Volts Input	(max.)	32	32
Shaft Diameter	(max.)	.250"	.250"
Temperature Rise		50°C.	40°C.
Weight		12 oz.	12 oz.

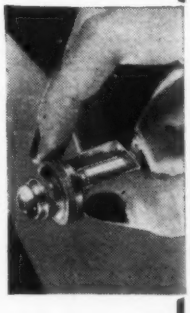
EICOR INC. 1501 W. Congress St., Chicago, U.S.A.
DYNAMOTORS • D. C. MOTORS • POWER PLANTS • CONVERTERS
Export: Ad Auriema, 89 Broad St., New York, U. S. A. Cable: Auriema, New York

THEY SAVE POWER, LAST LONGER, HAVE WIDER VOLTAGE RANGE

DRAKE *Patented* NEON Assemblies raise miniature jewel lighting to new heights of economy and efficiency! Power consumption is only 1/25 watt . . length of life 3000 hours . . . voltage range 105 to 125 volts! No. 50N offers a ½" smooth, clear jewel. Red glass jewel also available. The No. 51N without jewel applies where 180° visibility is desired. These popular patented Drake Assemblies are shipped complete with built-in Resistors and NE 51 Neon Lamps. Attractive plastic shields that cover and protect the Neon Lamps will be ready about April 1945.

WITH BUILT-IN RESISTORS FOR NE 51 LAMPS

The far greater economy, efficiency, and reliability of the new NE 51 NEON LAMPS has created a great deal of interest in our new NEON Light Assemblies. Drake *Patented* features have been widely copied. Get the original, specify "DRAKE".



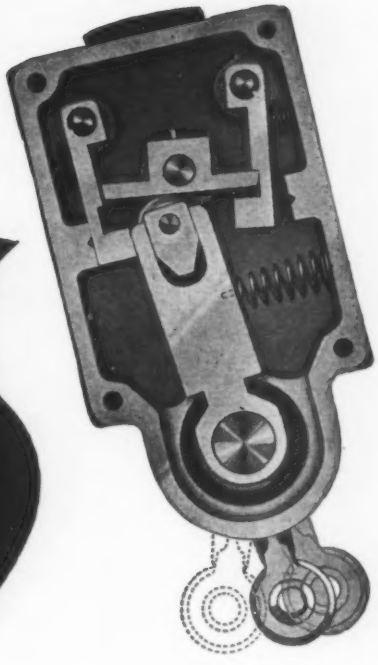
DRAKE

DRAKE'S Neon Pilot Light Assemblies are only two of a complete line of better Assemblies for every need! Do you want a copy of our catalog?

SOCKET & JEWEL LIGHT ASSEMBLIES

DRAKE MANUFACTURING CO.
1713 W. HUBBARD ST. • CHICAGO, U. S. A.

LOOK INSIDE



Look at the electrical side—wide contact gaps, pure silver contacts, wiping action prevents corrosion, double insulation, ample wiring space, sure make and break.

Look at the mechanical side—heavy construction, positive locking, hardened steel parts, antifriction bronze bushings, 29° lever overtravel with multiple spring. Standard or explosion-proof types.

Those are the reasons why more than 80% of all machine tool builders are using Snap-Lock Limit Switches.

Wide variety of standard applications, or may be engineered for the particular job. Get details in Bulletin EM-42.

SNAP-LOCK
TRADE MARK

The NATIONAL ACME CO.
170 EAST 131st STREET • CLEVELAND 8, OHIO

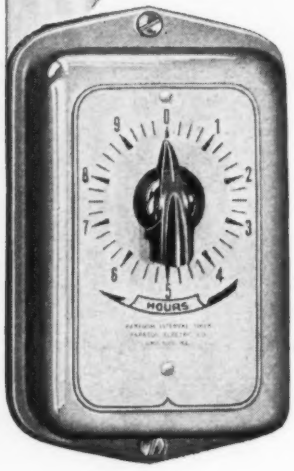
Acme-Gridley 4-6 and 8 Spindle Bar and Chucking Automatics • Single Spindle Automatics • Automatic Threading Dies and Taps • The Chronolog • Limit, Motor Starter and Control Station Switches • Solenoids Centrifuges • Contract Manufacturing

PRECISION CONTROL OF TIME INTERVALS

assured with

Paragon

PRESET TIMERS



2509 for surface mounting.

2509 for gang switch box or handy box mounting.

Paragon improved manually preset timers can be preset to perform a great variety of operations . . . to allow a given operation to continue for almost any pre-determined time limit . . . to close or open a circuit at the end of the preset time. Synchronous motor operated. Assures absolute accuracy of the timing cycle. Not affected by vibration or changes in ambient temperature. Supplied as standard with single pole, double throw switches and choice of 10 time ranges and 3 types of mounting . . . 2400 series for flush mounting, 2500 for surface mounting, 2900 for wall mounting.

Paragon Chicago
BUILDERS OF ELECTRICAL EQUIPMENT SINCE 1905

PARAGON ELECTRIC CO.
708 Old Colony Bldg. • Chicago 5, Ill.

Mr. Tops, the Paragon symbol of top quality.

FRACTIONAL H.P. MOTORS & GENERATORS and HOW THEY ARE USED

•

It was our plan to publish a booklet showing many of the interesting uses for fractional horse-power motors and generators, complete with photographs and schematic drawings—thought-provoking information for engineers planning their post-war products. So, we wrote our many customers and asked for information along those lines. Here is a typical reply:

"I have your letter in which you requested information regarding the use of "ELINCO" products. While I can attest to the excellence and reliability of your products, unfortunately I cannot at this time describe any specific application of such units because of the nature of my work. During the past several years all the work I have done has been of a confidential nature, and one cannot easily describe the application of your products without revealing the nature of the device."

Obviously, we have had to postpone our booklet. However, as soon as official release can be obtained to describe the many fascinating applications of our products, we will publish our booklet, a copy of which will be yours for the asking.

In the meantime, we will welcome descriptions of uses of fractional horse-power motors and generators, if they can be released, and will be delighted to place your name on our mailing list for "Fractional H.P. Motors and Generators . . . and How They Are Used" when we are able to publish it.

•

the electric indicator co.

115 PARKER AVE. GLENBROOK, CONN.

•

SPECIALISTS IN THE DESIGN AND PRODUCTION OF SPECIAL PRECISION FRACTIONAL HORSEPOWER MOTORS AND GENERATORS.

	CHECK these EXTRA VALUES	EMERSON-ELECTRIC MOTORS	OK
1	RELIABILITY... Time-tested	54 Years	✓
2	COMPLETE LINE... Sizes 1/200th to 5 H.P.	For All Appliances	✓
3	ENGINEERING SERVICE... Design—Development	Complete Cooperation with Manufacturer	✓
4	TRADE ACCEPTANCE... Sales value in name	Long Established	✓
5	NATIONAL ADVERTISING... Consumer Acceptance	Extensive	✓

These are values you can't SEE in ELECTRIC MOTORS

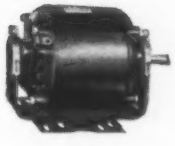
A motor has two jobs—it must power your product and protect your future market. That's why it pays to look *back* of the motor for the extra values that go beyond the physical appearance.... Five hidden values back of Emerson-Electric Motors are tabulated above. Check them carefully—because no matter how good your product may be, it is finally no better than the motor that drives it.

COMPLETE LINE—Sizes 1/200 to 5 H. P.... Particularly valuable to manufacturers producing motor-driven equipment of varying types, sizes and capacities is the wide choice of motors offered by Emerson-Electric, for practically all classes of domestic and commercial appliance drives.

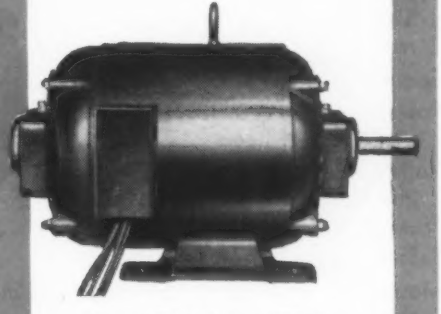
INVESTIGATE *the extra values* back of Emerson-Electric Motors. Give your products this *extra sales value.*

THE EMERSON ELECTRIC MANUFACTURING CO. • ST. LOUIS 3, MO.

Branches: New York • Chicago • Detroit • Los Angeles • Davenport 3



Emerson-Electric split-phase motors are built in sizes from 1/20 H. P. to 1/4 H. P., for operating conditions requiring low-starting-current characteristics.



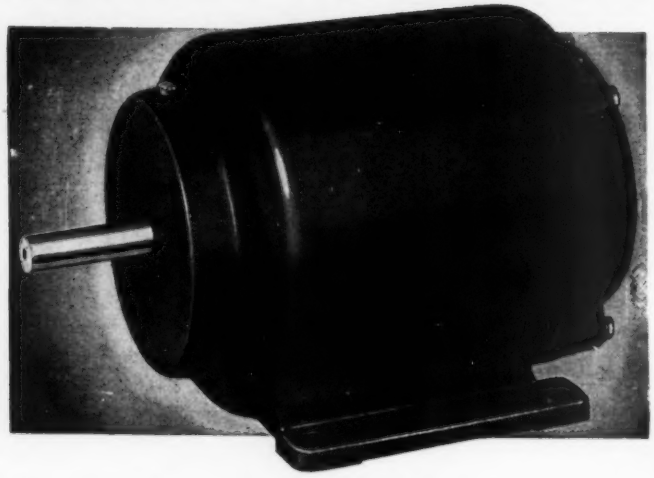
Emerson-Electric type IR induction-repulsion motors are built in sizes from ¾ H. P. to 5 H. P. They possess high-starting-torque characteristics that are particularly adaptable to commercial drives where an important requirement is the ability to start heavy loads.

Emerson-Electric manufactures a complete line of motors in single-phase, polyphase and direct-current types, in sizes up to 5 H. P.

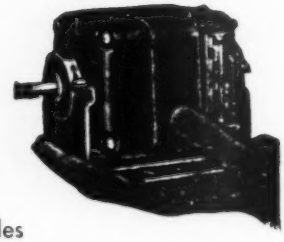
EMERSON ELECTRIC

MOTORS · FANS — APPLIANCES

OHIO
SMALL MOTORS



for General Purpose Applications



Types—Split Phase, Capacitor, Shaded Pole, and Direct Current
Speeds—1100, 1700, 3400 RPM
Power—1/80 to 1/20 HP, depending on speed
Voltages—up to 440 A.C. and 250 D.C.
Frequencies—60, 50, and 25 cycles
Bases—Solid, Resilient or Flange
Mountings—Horizontal, Sidewall, Ceiling or Vertical, with shaft up or down
Efficiency—High for such small powers

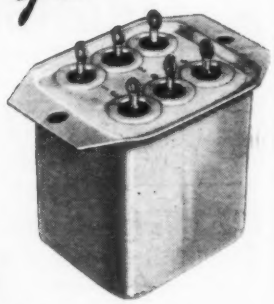
OHIO MOTORS INCLUDE

- Split-phase induction to 1/3 HP
- Direct Current to 1 HP
- Capacitor to 2 HP
- Polyphase to 2 HP
- Aircraft Motors
- Shell Type 7½ HP
- Torque to 100 oz. ft.
- Shaded Pole to 1/30 HP
- Synchronous to ¼ HP
- A.C. to D.C. Motor Generators to 500 watts
- High to Low Voltage D.C. Dynamotors up to 300 Watts

What is your problem?

THE OHIO ELECTRIC MFG. CO.
5911 Maurice Avenue — Cleveland 4, Ohio

THESE TRANSFORMERS *Dare Not Fail!*



● These hermetically sealed Acme transformers are components of some of the most important equipment used by our armed forces. And, because transformers are the very heart of such equipment,— *They Dare Not Fail!*

THE ACME ELECTRIC & MFG. CO.
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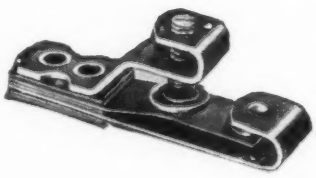
Acme ACME Electric

APPLIANCE
THERMOSTATIC CONTROLS

ULANET
15 YEARS OF "KNOW-HOW"



TYPE ASK-SB
THERMOSTAT FOR
BUILT-IN USE

Design Data Available

GEORGE ULANET COMPANY
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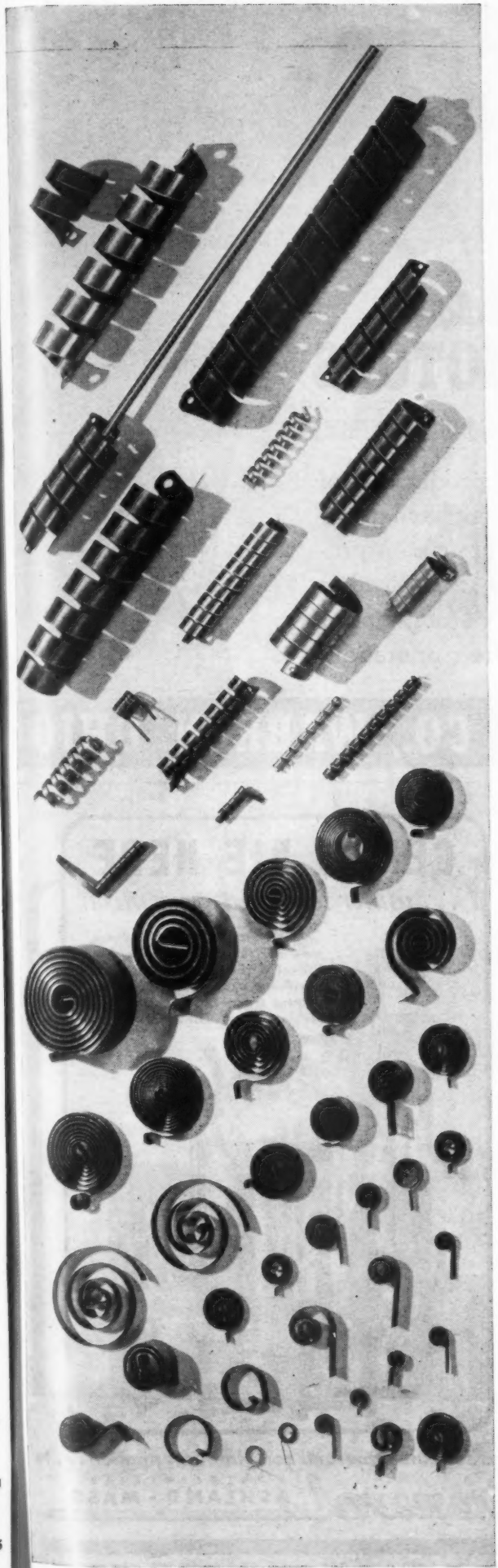
Thermostats DEVELOPED, DESIGNED AND MANUFACTUR SINCE 1930

ALSO A COMPLETE LINE OF THERMAL TIMERS



ANOTHER WILCO DEVELOPMENT

WILCO THERMOMETAL (Thermostatic Bimetal)

Morflex

Higher Deflection Rate • Greater Electrical Resistivity

This new high action WILCO Thermometal broadens the range of Thermostatic Bimetal application.

PROPERTIES AND CHARACTERISTICS—Morflex provides a 40% higher temperature deflection and electrical resistivity for devices or instruments requiring extremely high sensitivity from 50° to 350°F. Whether the desired function is Temperature Indication, Temperature Control, or Temperature Compensation, Morflex operates dependably and uniformly . . . saves space.

WIDE APPLICATION FOR DOMESTIC AND INDUSTRIAL DEVICES—Morflex is supplied in strip or in straight cantilever blades, U-shapes, spirals and helices . . . or as parts of assemblies with shafts, studs, brackets, contacts, braids or springs.

CONSULT OUR ENGINEERING DEPARTMENT—Write the WILCO Engineering Department for help in developing the proper application of WILCO materials to your products. Send for FREE copy of the WILCO Blue Book. It contains charts, formulae, and full descriptions of *all* WILCO Thermometals and other products:

WILCO PRODUCTS INCLUDE:

CONTACTS—
Silver
Platinum
Tungsten
Alloys
Sintered Powder Metal

THERMOSTATIC BIMETAL—
High and Low Temperature with new high temperature deflection rates.

PRECIOUS METAL COLLECTOR RINGS—
For rotating controls

SILVER CLAD STEEL JACKETED WIRE—
Silver on Steel, Copper, Invar or other combinations requested.

ROLLED GOLD PLATE

SPECIAL MATERIALS

THE H. A. WILSON COMPANY
105 Chestnut Street, Newark 5, N. J.
Branch Offices: Chicago—Detroit—Los Angeles

SPECIALISTS FOR 30 YEARS IN THE MANUFACTURE OF THERMOMETALS • ELECTRICAL CONTACTS • PRECIOUS METAL BIMETALLIC PRODUCTS

Peerless
QUALITY MOTORS

SINGLE PHASE • POLYPHASE • DIRECT CURRENT

Fifty-one years in the production of quality electrical equipment have given Peerless engineers and craftsmen proficiency and experience in designing and building motors of maximum efficiency and trouble-free operation.

THE PEERLESS ELECTRIC CO., WARREN, OHIO

SYNCHRON

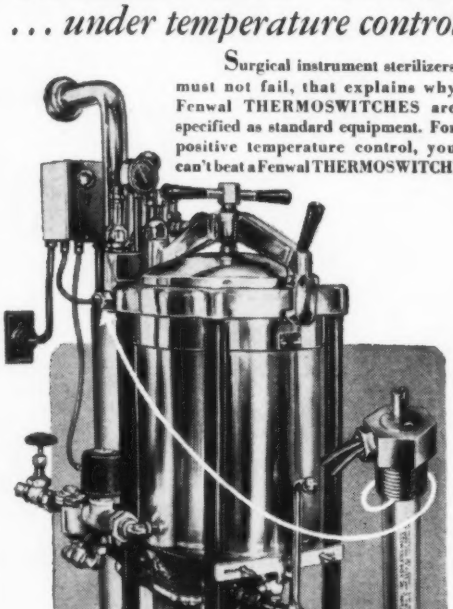
★

— still at war —
but expecting soon
to be demobilized!

★ With the reduction of war requirements we will be at liberty to channel our efforts into the production of SYNCHRON synchronous timing motors, time machines, and clock movements. If you make timing devices of any kind, we suggest you write us now for engineering data. HANSEN MFG. CO., INC., Princeton 5, Indiana.

GERMS DIE HERE
... under temperature control!

Surgical instrument sterilizers must not fail, that explains why Fenwal THERMOSWITCHES are specified as standard equipment. For positive temperature control, you can't beat a Fenwal THERMOSWITCH!



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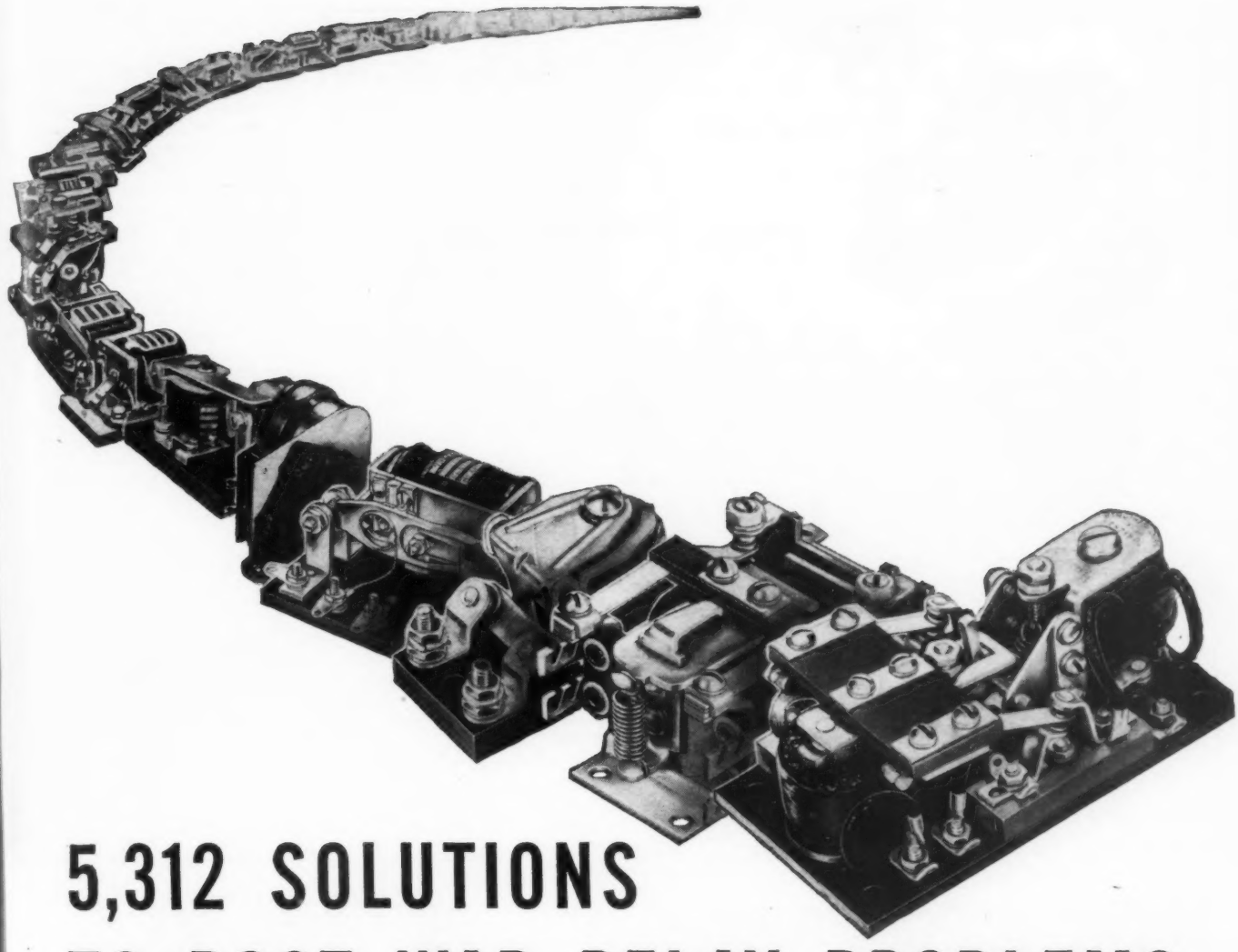

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Shire Moot: A meeting of the court when knighthood was in flower, presided over by sheriff and landowners. The usual sentence was bodily roasting or dunking, to the amusement of all but the accused.

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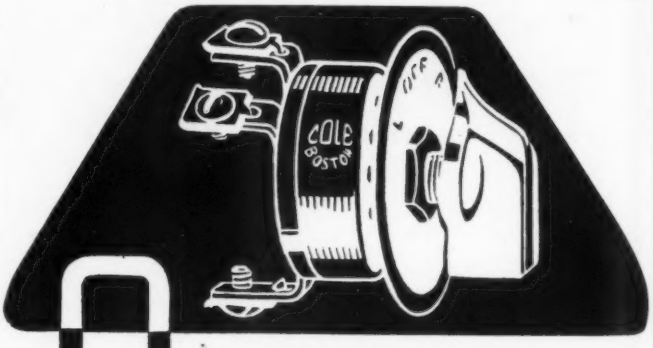

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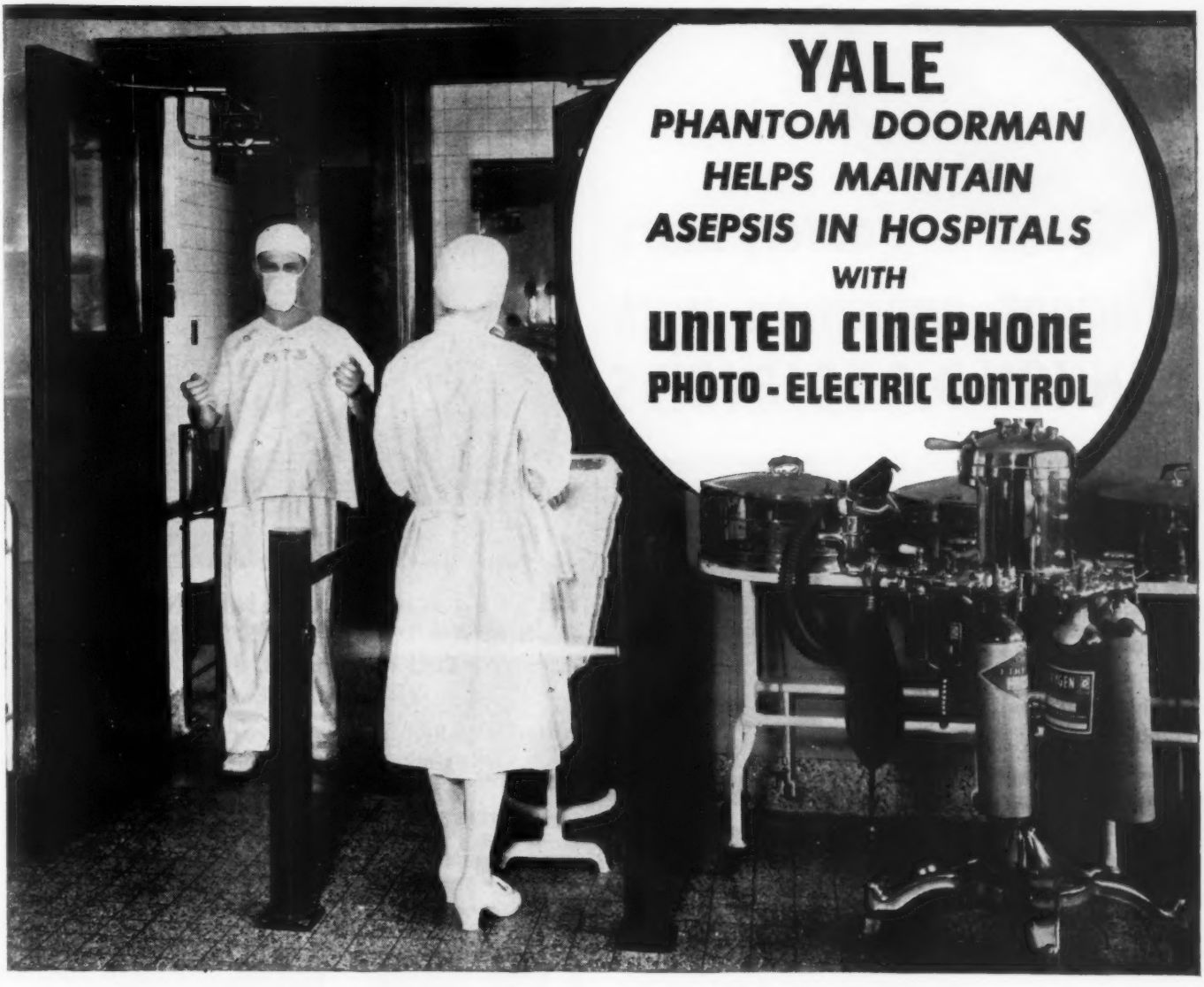

The Electric Eye Door Opener is already widely in use in restaurants ond other public buildings . . . In hospitals, where sanitation is of even more importance, it is still comparatively new. Located between major operating rooms and the doctors' scrub room it makes possible the automatic opening and closing of doors without touch of hands. These controls are the result of the merging of Yale and Towne's extensive knowledge of mechanical door devices with the Electronic engineering of United Cinephone Corporation. They can be set to operate within whatever interval of time is required between the opening and closing of the door.

OTHER APPLICATIONS of United Cinephone Electronic controls are almost without limit. If you have a problem of measuring, gauging, counting, sorting, heating, or some other operation in your plant, which is costly and unreliable, you will want to investigate the possibility of solving the problem ELECTRONICALLY. That's where our extensive experience and facilities in Electronic design, engineering, and manufacturing can be of invaluable help. Your inquiry will be welcome.

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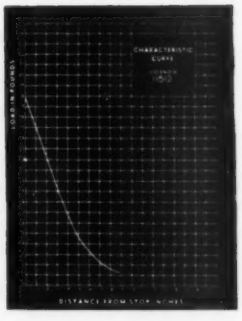
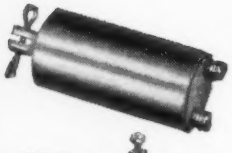
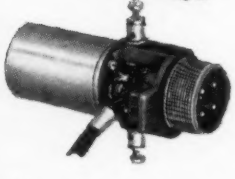


Response characteristic charts like the above (test at 28 volts) are found in Solenoid Bulletin.

A wide selection of Cannon Solenoids are built for various combinations of voltages, pull, armature travel, duty cycle, etc. to suit design requirements. Nominal voltages are 12 and 24; others by special order. Eight types have "holding" features.

As a reliable means of controlling or operating various devices, they are used for retarding magnetos in starting engines, operating hydraulic valves and mechanical clutches, firing machine guns, arming and releasing bombs, dropping auxiliary fuel tanks, locking retracting gears, film-winding mechanisms and for shutter control on special cameras. These are only a few of the possible applications.





A copy of the Cannon Electric Solenoid Bulletin—34 pages of diagrams, data and photos of the complete line will be sent free for the asking. Address Dept. A-106, Cannon Electric Development Co., 3209 Humboldt Street, Los Angeles 31, California.

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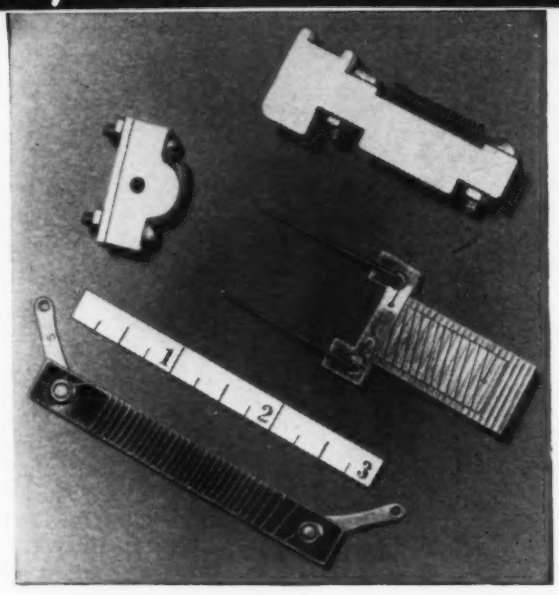

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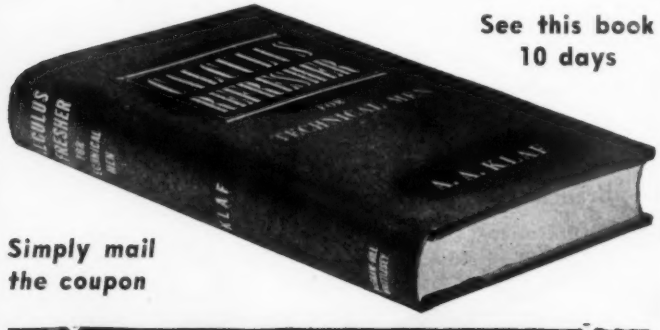

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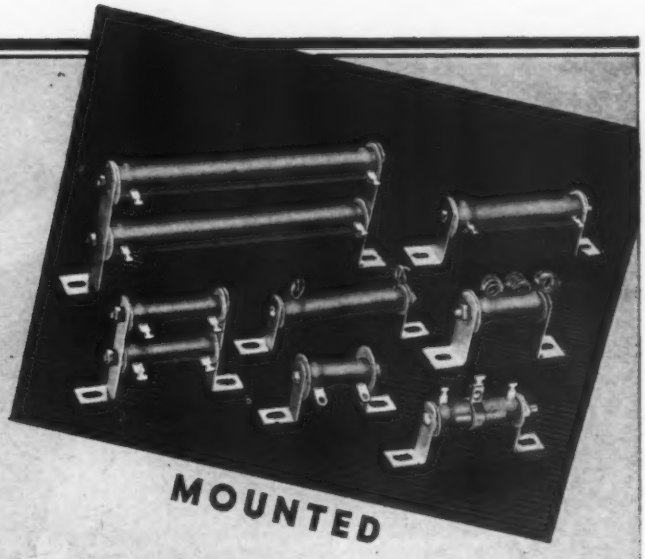

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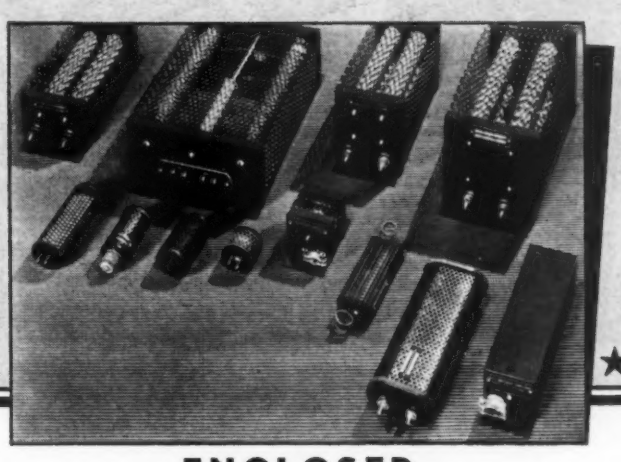

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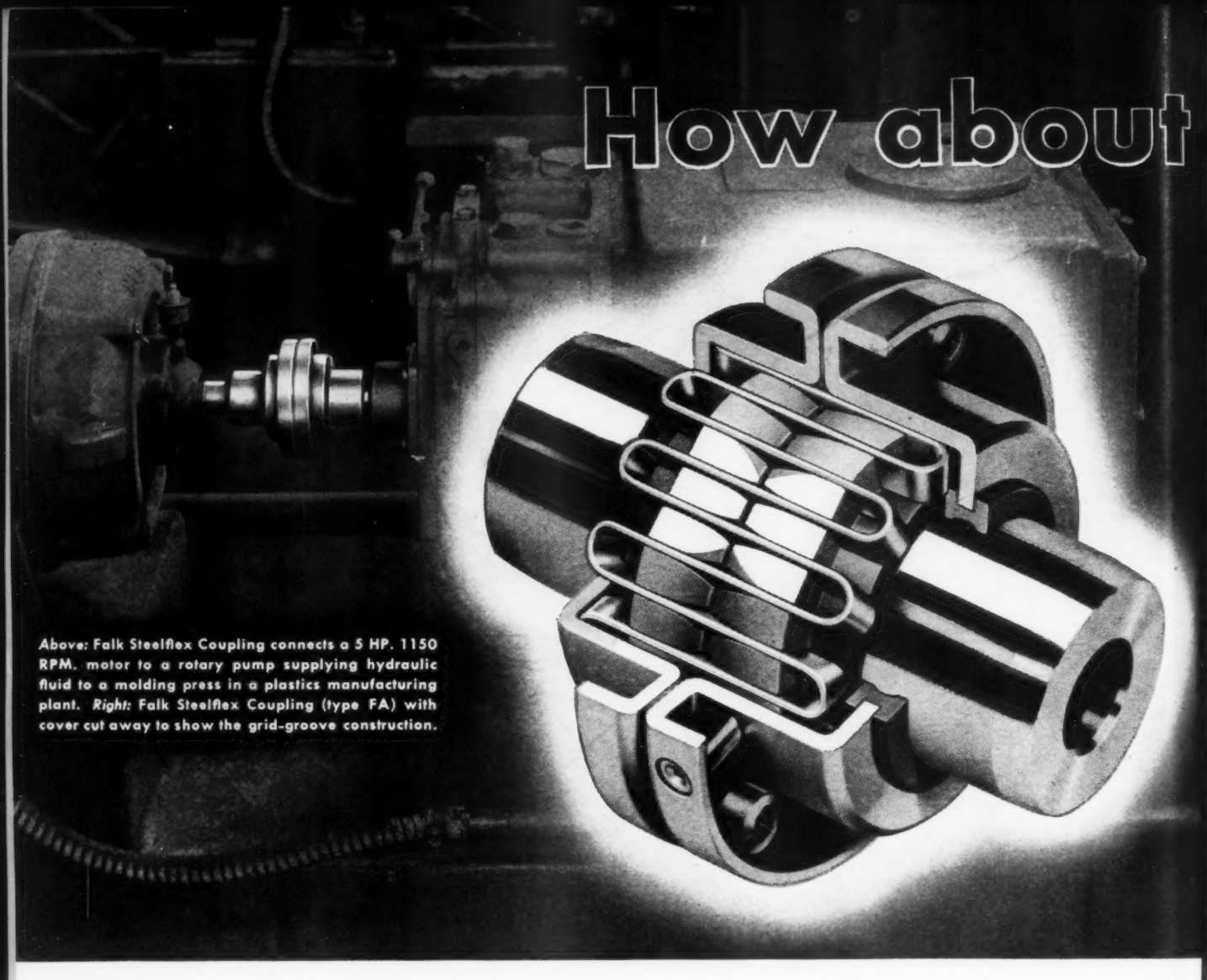

Above: Falk Steelflex Coupling connects a 5 HP. 1150 RPM. motor to a rotary pump supplying hydraulic fluid to a molding press in a plastics manufacturing plant. *Right:* Falk Steelflex Coupling (type FA) with cover cut away to show the grid-groove construction.

Flexible and Resilient Grid-Groove Design Effectively Cushions Loads . . . Absorbs Shocks . . . Adjusts for Misalignment . . . Provides for End Float

FALK Engineers have long recognized the importance of, and necessity for, connecting the shafts of a driving and a driven member by a coupling that is both flexible and torsionally resilient.

As pioneers in the design and manufacture of precision gear drives, these engineers know that a coupling must be resilient to the degree that it definitely improves the character of the motion imparted to it.

This qualification extends beyond the mere connecting of shafts under slight angular and parallel misalignment without imposing undue loads on the bearings and shafts of connected machinery—which is the ordinary concept of coupling design.

In addition to providing flexibility and torsional resilience, proper coupling design dictates the use of materials that will insure years of trouble-free service.

Therefore Falk Steelflex Couplings provide both essentials of desirable coupling performance, insuring *both* flexibility and the torsionally resilient action that so effectively cushions loads, absorbs shocks, dampens vibration, adjusts for angular and parallel misalignment, and allows free end float for the shafts of driving and driven members.

How and why Falk Steelflex Couplings do all this is explained on the opposite page. Here, indeed, is a short course in efficient coupling design.

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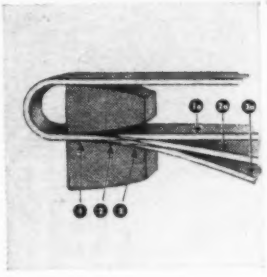
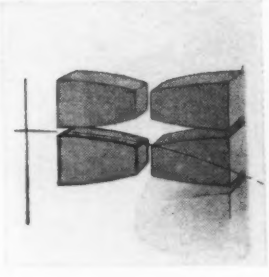
a short course in

Coupling Design?

WHY and HOW Falk Steelflex Couplings Perform Better

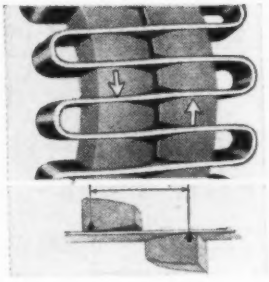
OW THE GRID-GROOVE DESIGN UNCTIONS. Power is transmitted rough a resilient grid member made of rome alloy steel with an elastic limit of 25,000 pounds per square inch and an timate strength of 250,000 pounds er square inch. This grid fits snugly into rved grooves cut into the hubs of the upling.

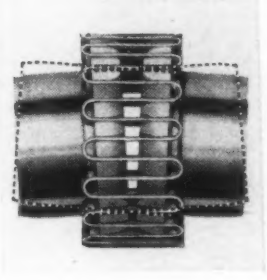




HOW THE GROOVES ARE DESIGNED. The identical hubs are moderately high carbon bar steel, forged steel, or Falk alloy cast steel. Into these hubs, grooves are cut in a precise arc, with radius and length proportional to the size of the coupling, to provide a snugly fitting slot for the grid member and a bearing surface from outer to inner edge of the hub.

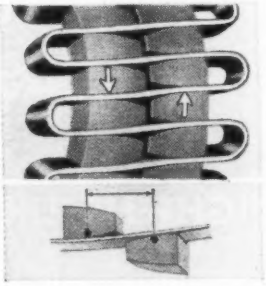
T LIGHT LOADS, the grid member ears only at the outer edges of the rved grooves in the coupling hub, as own at right and at *1* and *1a* in the diagram above. This permits a long, free astic span between the outer edges of oth hubs. Power is transmitted through most the entire length of the resilient ngs of the grid member.

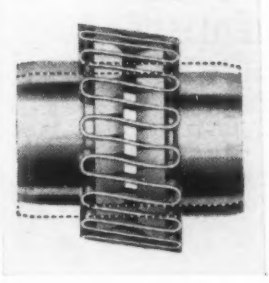




ANGULAR MISALIGNMENT. Under angular misalignment the design of the Falk Steelflex coupling permits a rocking and sliding action of grid and hubs that allows the greatest freedom of accommodation to angular misalignment, while at the same time transmitting the power through the resilient grid with no lost motion or backlash.

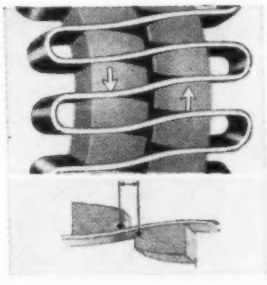
T NORMAL LOADS, the grid bears n a larger area of the grooves (*2*, a in diagram) and the span of the rid is automatically shortened as the ad increases, enabling it to transmit ore power without increasing internal ress. The grid member maintains its apacity to absorb shocks, dampen ibration, and cushion the load.

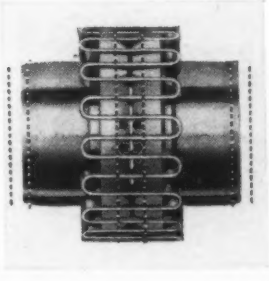




PARALLEL MISALIGNMENT. When parallel misalignment is involved, the resilience of the grid-groove combination comes into full play. The movement of the grid in the lubricated grooves accommodates the misalignment, while still permitting full function of the grid-groove action of the coupling in absorbing shock and dampening vibration.

T PEAK LOADS, the rungs of the grid ember then bear over almost the enre curved surfaces of the grooves (*3*, a in diagram) and the span of the grid ecomes very short. The coupling still emains torsionally resilient. Also under e impact of shock loads the grid ember flexes and transmits power moothly and evenly.





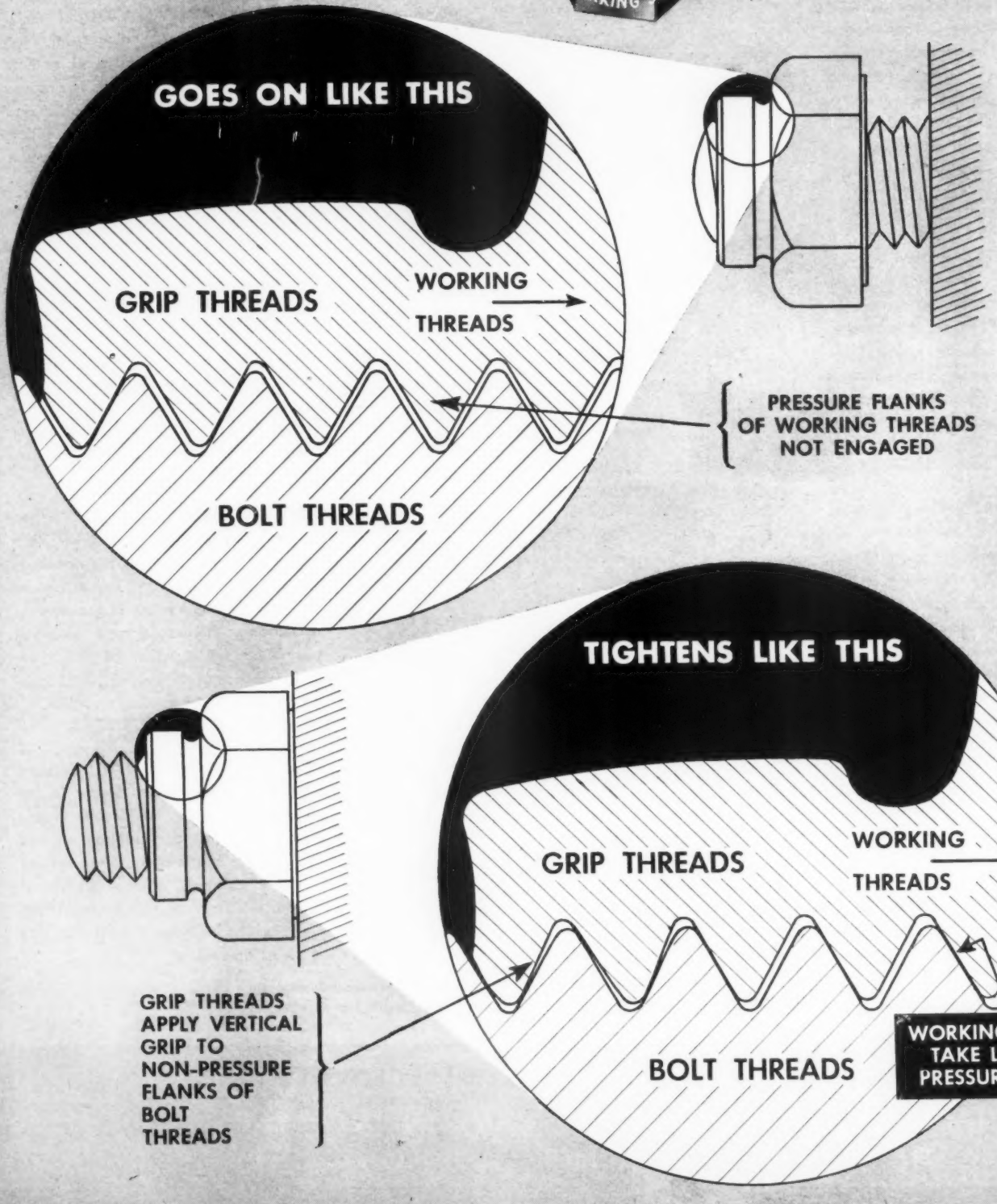
PERMITS FREE END FLOAT. Because the grid member slides freely in the lubricated grooves, the Steelflex coupling permits free and independent end float for the shafts of both the driving or driven members, or of either one. If it is desired that end float be restricted, provision can be made to limit it to any required amount.

There are 13 types and 33 sizes of Falk couplings to meet all requirements. For specific information and recommendations to meet your needs, call the nearest Falk representative or distributor.

FALK ... A GOOD NAME IN INDUSTRY

Here's what happens..

IN THE LAMSON LOCK NUT


GOES ON LIKE THIS
GRIP THREADS
WORKING THREADS
BOLT THREADS
PRESSURE FLANKS OF WORKING THREADS NOT ENGAGED
TIGHTENS LIKE THIS
GRIP THREADS
WORKING THREADS
BOLT THREADS
GRIP THREADS APPLY VERTICAL GRIP TO NON-PRESSURE FLANKS OF BOLT THREADS
WORKING THREADS TAKE LOAD ON PRESSURE FLANKS

WHEN YOU APPLY A LAMSON LOCK NUT TO A BOLTED ASSEMBLY..AND IT WILL HOLD TIGHT RIGHT WHERE YOU LEFT IT

● When you apply a Lamson Lock Nut you spin the nut on the bolt thread as freely as a Class 3 fit permits, until the bolt thread engages the thread in the *locking crown collar.* Then you'll need a wrench to seat the nut against the work—for it's the grip of the threads in the *locking crown collar* that locks it on the bolt.

Here's what happens. When the bolt is tightened by the nut, the "pressure flanks" of the working threads of the nut stress the bolt and force the collar back toward its original round form. As this occurs, the "non-pressure flanks" of the grip threads of the nut are engaged, and through them is applied the vertical pressure which locks the nut. There is no pitch interference since the thread has the same lead throughout.

Lamson Lock Nuts are tapped in the usual way, then the threaded portion of the *locking crown collar* is distorted from the round on opposite sides, causing it to grip the bolt thread like a vise. A resilient, permanent spring action is imparted by heat treatment to the *locking crown collar* of the nut. This truly is a *lock nut* —and *it is all metal!* Because it is all metal it can be used under any combination of these conditions—*Heat:* the Lamson Lock Nut is in use at elevated temperatures up to 800° Fahr. *Ice:* it is used in guns and motorized equipment in Alaska. *Steam:* all metal, it is unaffected by steam. *Oil and Water:* all metal, this nut is unaffected by either.

Re-use in the field is important when supplies are short and what is on hand must do the job. Re-use in domestic civilian applications is just as important to conserve supplies. In impartially supervised laboratory tests the Lamson Lock Nut held tightly after repeated applications, removal torque dropping less than 1 ft. lb. per cycle in 10 on-and-off cycles.

On applications where vibration and shock are severe, Lamson Lock Nuts are meeting specification requirements. They are made in standard sizes from #10-32 up to 2-inch diameters, and unless otherwise specified, are provided with a non-seizing, rust-resistant black finish. If you have applications where vibration shakes nuts loose—make your own tests with Lamson Lock Nuts. They may solve a problem for you. Ask for samples, or ask for a Lamson engineer to call and talk it over.

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"SIMPLIFIED STOCK LIST"—Of bolts, nuts and screws, conforming to latest revisions of the Office of Price Administration, and of great value in showing you in what ratio quantities of various standard products are kept in stock for deliveries, by your jobbers and in our own (and other bolt manufacturers') warehouse stocks. *Sent gratis.*

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Please send us ☐ Lamson Blue Book ☐ Bolts, Nuts & Screws ($1.00)
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Send information on ☐ Cap Screws and Set Screws ☐ Cotters
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BOLTS · · NUTS · · COTTERS · · CAP SCREWS · · · SPECIALS

Your Jobber Stocks the Lamson Line

400,000

SPECIALIZED ITEMS YOU CAN ORDER BY SIZE AND NAME

SCREWS

★ MEETING YOUR SPECIFIC NEEDS

★ ACCURATELY MADE, UNIFORM

★ DEPENDABLE

BOLTS

In perhaps no other field of manufacture is the American talent for standardization and efficiency more clearly shown than in the field of Industrial Fasteners. Today, designers and fabricators of small appliances or huge structures can select fasteners of the types and sizes they need from over 400,000 standard items. Many of these are specialized fasteners, developed to serve a definite useful purpose.

The development of uniform standards has materially reduced the variety of items made, simplifying your buying problems; the use of modern precision methods in the manufacture of fasteners, assures interchangeability and accurate fits.

To guide the designer and fabricator of products and structures of all types and sizes, there is available a wealth of authoritative design data. When you base your designs upon this proved engineering data and the known properties of fasteners, you can have complete confidence in the ultimate results.

NUTS

RIVETS

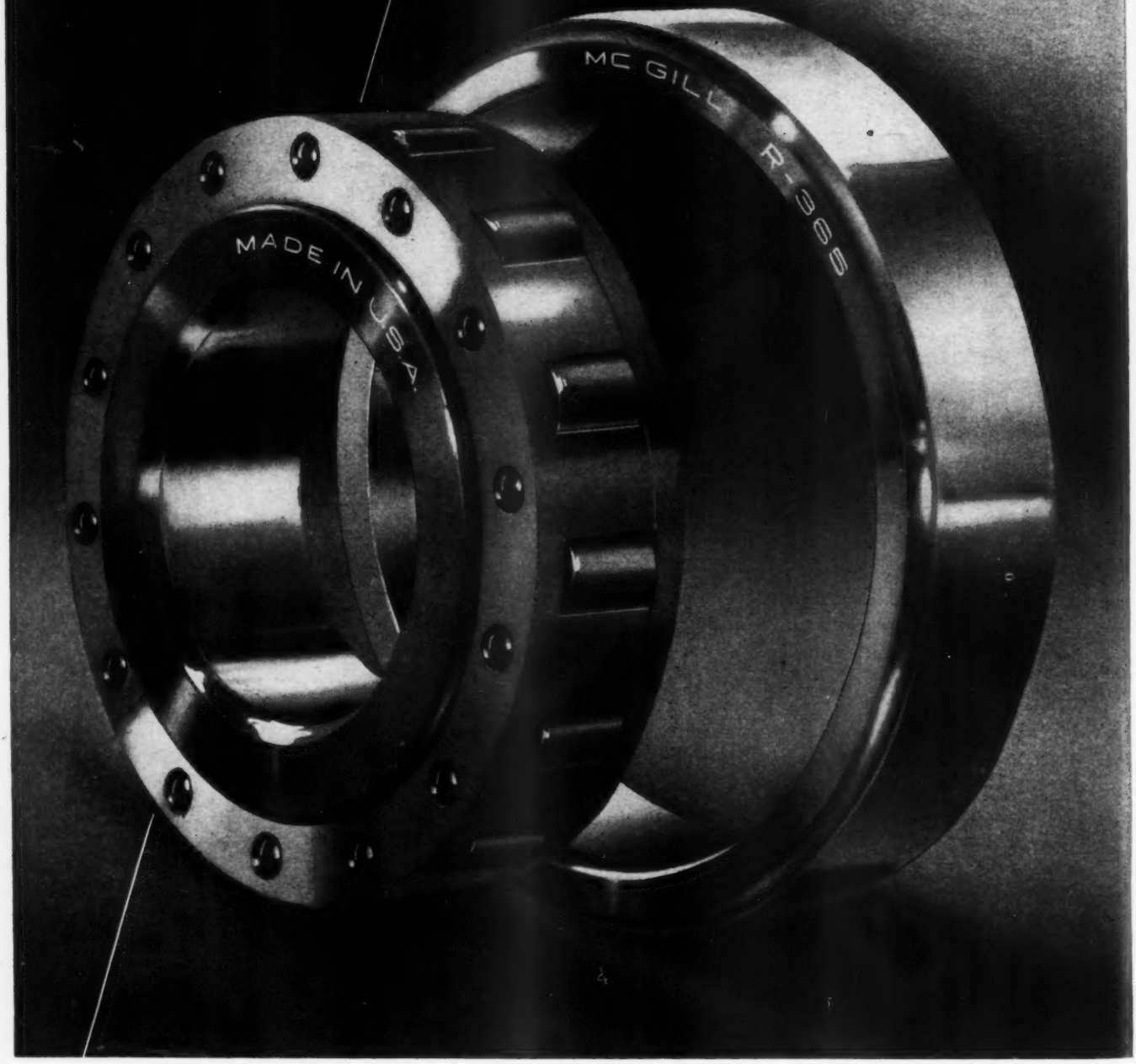
AMERICAN INSTITUTE OF BOLT, NUT AND RIVET MANUFACTURERS

1550 Hanna Building · Cleveland 15, Ohio

ROLLER BEARINGS

WITH *Bronze Retainers*

Being precision-built, with precision tolerances, McGILL Roller Bearings with Bronze Retainers meet modern industrial needs. Engineers are increasingly appreciative of their trouble-free performance, their extra load capacity and long life. Special bearings built to order. Write for further information or engineering consultation.



McGILL MANUFACTURING COMPANY, INC. *Manufacturers of Ball and Roller Bearings*
VALPARAISO, INDIANA

"Pipelines that flex" for OIL...STEAM...GAS

A few of the many American Flexible Metal Hose and Tubing assemblies engineered complete with fittings or couplings for specific applications.

VIBRATION or continual movement in a connection is bound to cause trouble sooner or later . . . unless the connection is *engineered* for the job.

Illustrated are a few American Flexible Metal Hose and Seamless Tubing assemblies, each of which *is* designed to meet a specific set of conditions.

Such a connection can be developed for you . . . with the necessary resistance to pressure, temperature, chemical or abrasive action and mechanical stress.

For detailed information on the range of types and sizes of "American" products, write for Publication SS-50. Manufacturers, engineers and machine designers alike will find it a thoroughly practical guide.

BUY WAR BONDS • Buy all you can • Keep all you buy

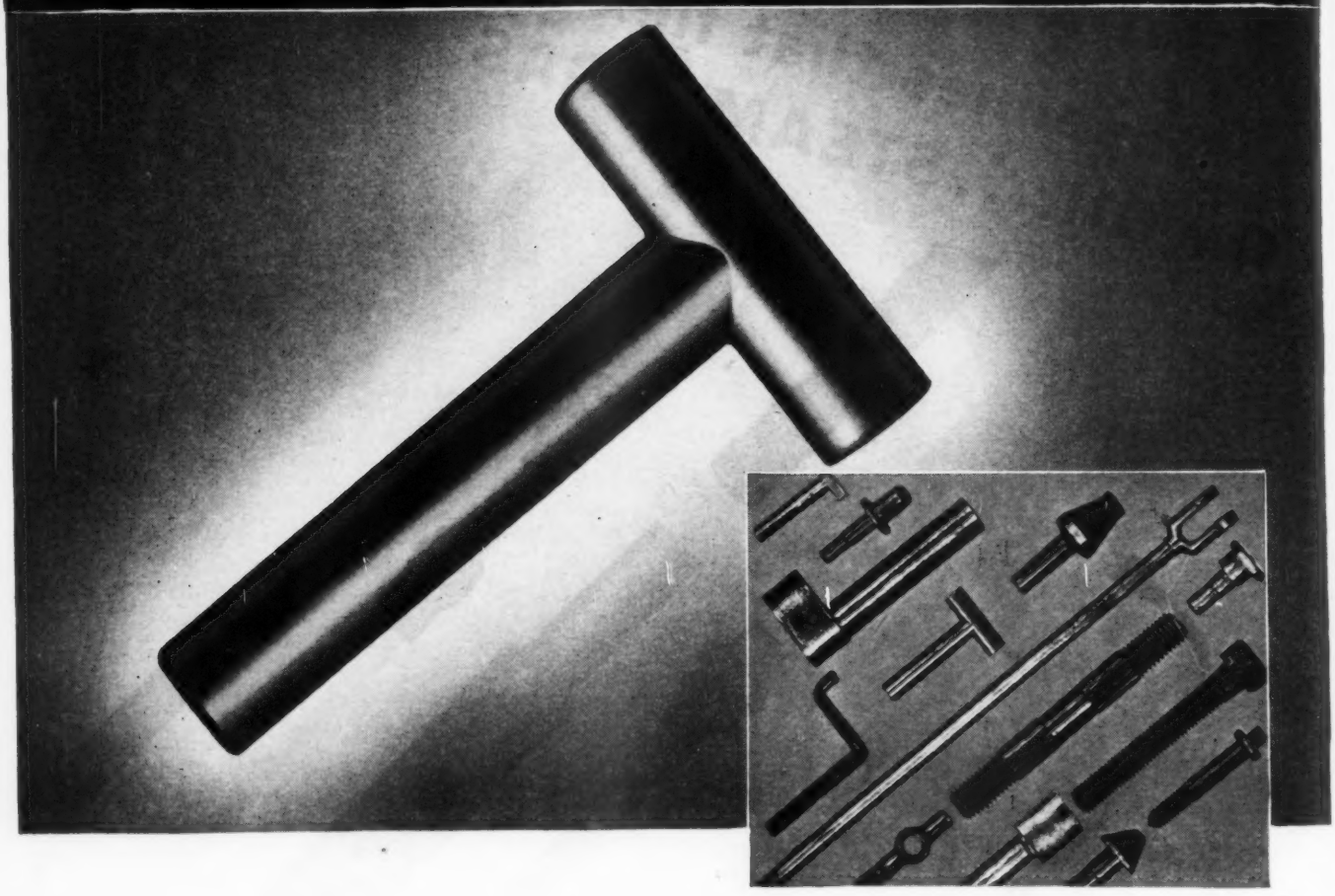
ANACONDA
from mine to consumer

American Metal Hose

AMERICAN METAL HOSE BRANCH OF THE AMERICAN BRASS COMPANY • General Offices: Waterbury 88, Conn.

Subsidiary of Anaconda Copper Mining Company • In Canada: ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*

100 YEARS *Making strong the things that make America strong*



If you need Parts like these

...have you considered COLD-FORGING?

A great variety of metal shapes are produced on the same high-precision, high-production machinery that is used to cold-forge RB&W EMPIRE bolts.

Cold-forging gives you the maximum of all the characteristics you would undoubtedly want in such a product —

Strength. Cold-forging on RB&W equipment increases tensile strength; the grain is intensified, flow lines in the metal are preserved. The operation provides an automatic inspection of the material.

Accuracy. RB&W cold-forging machinery can work to close tolerances and produce parts of extreme accuracy and fine finish.

Economy. Such parts can often be produced at much lower cost, due to the high speed production and the virtual elimination of scrap waste.

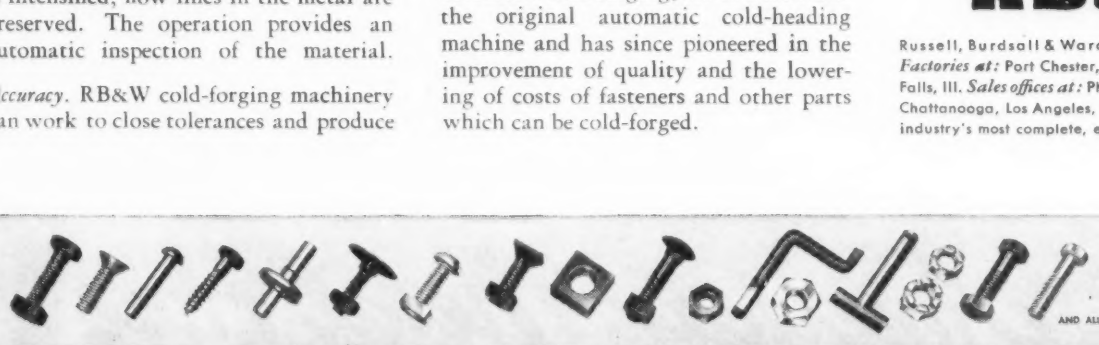
THE LONGEST EXPERIENCE IN AUTOMATIC COLD-FORGING

This is RB&W's 100th year. The history of this company is also the history of automatic cold-forging, for it introduced the original automatic cold-heading machine and has since pioneered in the improvement of quality and the lowering of costs of fasteners and other parts which can be cold-forged.

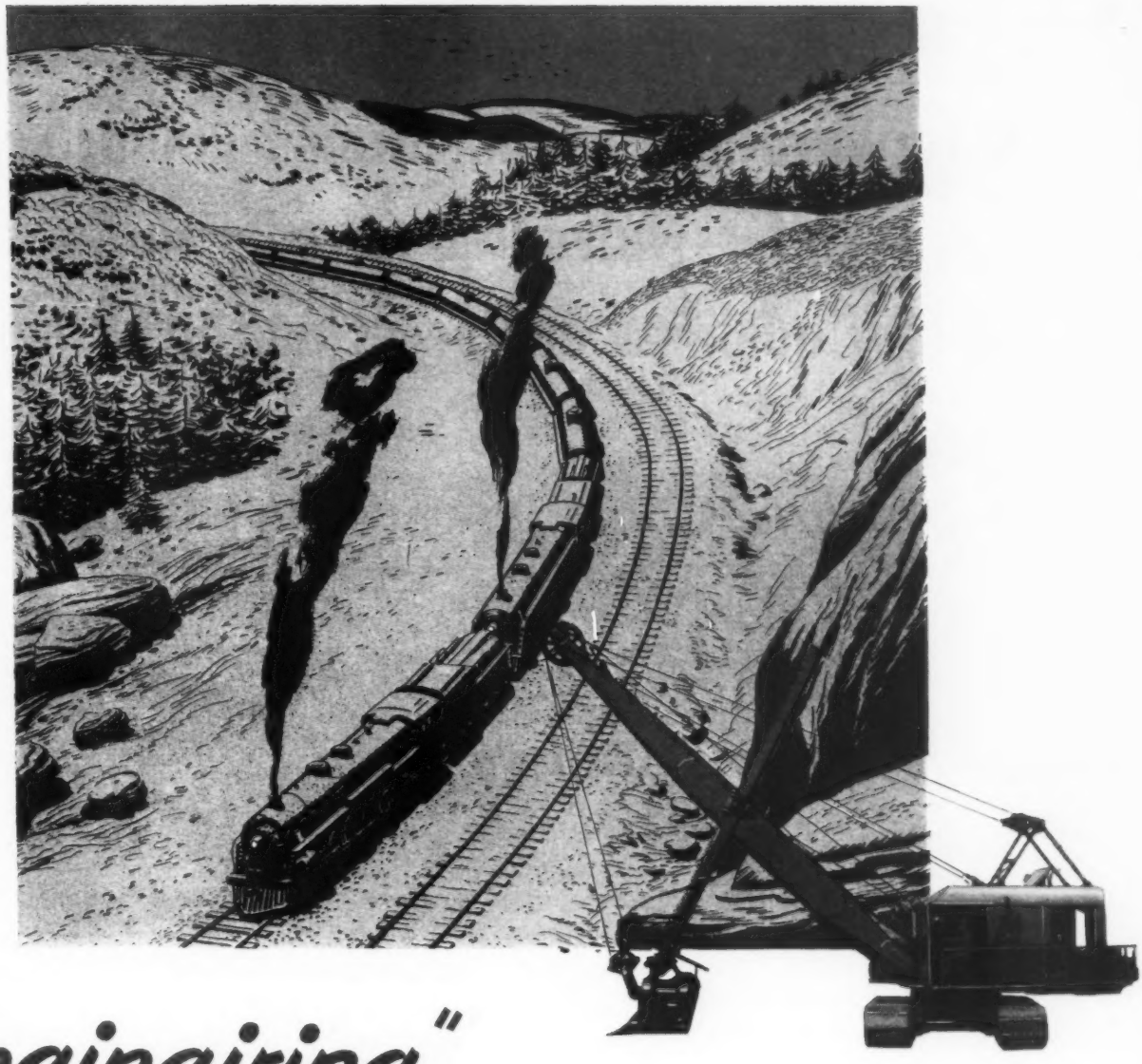
In planning new parts, consider the many metal shapes which can be produced by cold-forging and also that RB&W's experience and facilities make it your logical source of supply. At present, wartime commitments have largely monopolized those facilities; in designing for postwar, keep in mind the advantages of this method.

RB&W

Russell, Burdsall & Ward Bolt and Nut Company. *Factories at:* Port Chester, N. Y., Coraopolis, Pa., Rock Falls, Ill. *Sales offices at:* Philadelphia, Detroit, Chicago, Chattanooga, Los Angeles, Portland, Seattle ... with the industry's most complete, easiest-to-use catalog.



RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY



"Enginairing"

helps to *cross* mountains and helps to *move* them!

When mile-long trains of war materials must cross a mountain, the powerful locomotives can do only part of the job. The locomotives can take trains up the grades but the brakes are relied on to get them down . . . and that's where "Enginairing" has played a vital part.

Uniform brake application and release throughout the train are required to assure smooth handling and thereby protect lading and equipment. Enginairing developed the necessary qualities. The braking impulse travels the length of the train in approximately the time that the sound of the whistle travels from engine to caboose. By a few inches of movement of a small handle, the engineer commands a hundred cars or more.

The same Enginairing that has helped the railroads work transportation miracles, is helping industry, too. On modern earth-moving equipment, for instance, the operator need no longer muscle heavy levers. Instead, with the touch of a finger, he moves the handles of small W-A-B controls . . . and governs an entire cycle of operations. The actuating mechanism can be designed to handle any force from ounces to tons. Interlocks can be provided, to safeguard equipment from damage through incorrect manipulation.

Enginairing can make a big contribution to modernizing products and improving production, in post-war times. When that day comes, remember that our 76 years of Enginairing experience will be ready and willing to serve you.

WESTINGHOUSE AIR BRAKE COMPANY

INDUSTRIAL DIVISION

General Offices:
WILMERDING, PA.

WABCO PACKING

COMPRESSORS

REMOTE CONTROLS

A forward-looking American manufacturer offers Advanced Careers to a few qualified engineers and scientists

★ ★ ★

Top salaries plus high royalty earnings

★ ★ ★

Excellent laboratory in fine building located in beautiful Southern New England community

IN order to carry out a highly developed program of growth and expansion, we seek to augment the staff of our creative engineering laboratories with outstanding talent...and are prepared to do the things necessary to obtain it.

Applications are therefore invited from key engineers, research men and physicists experienced in industrial electronics, industrial control equipment, the design of automatic machines and allied fields. There are openings to satisfy the chief engineer, department head, project engineer, research engineer and the basic research scientist.

Salaries will at least equal those paid by other leading companies in the field, *but in addition, each candidate will receive a graduated percentage royalty on the sale of all products he develops. A portion of this royalty continues even if he later leaves the company.*

The conditions under which you will work are ideal. Our laboratory—housed in a splendid building—is well-equipped. You will be furnished with everything necessary to carry out the projects under your direction. The laboratory is located in one of the most charming residential communities of southern New England within commuting distance of New York—fine homes, excellent schools, modern shops and stores.

In order to receive fullest possible consideration, your application should present a detailed and comprehensive account of your experience and accomplishments, with particular emphasis on patents you may have obtained and contributions you have made to the origin or improvement of devices or techniques in your field.

The engagement of any candidate, of course, must be in accordance with War Manpower Commission and wage and salary regulations. If your present status precludes a change in position at this particular time, contractual arrangements can be made for you to join the staff at a later date.

We choose not to reveal the name of this corporation in this advertisement but every candidate interviewed will have the fullest opportunity of learning everything he wants to know about us. Further, your letter of application will be seen only by principals and will be held in the strictest confidence. All our staff knows of this advertisement.

Please address your letter to Box PW-992, Product Engineering, 330 W. 42nd St., New York 18, N. Y.

★

Man's genius for making things is limited only by the physical properties of the substances used to make them.

From these presses come DEPENDABLE AIRCRAFT DIAPHRAGMS

● Aircraft diaphragms differ greatly.
Some operate in air,
others in chemicals or water,
and some in various types of gasoline—
from 100 octane to 40% aromatic hydrocarbons.
Sirvene meets any of these requirements.

At temperatures ranging from −65° to +180° F,
diaphragms must be efficient and dependable;
they must be flexible to permit careful calibration,
yet tough and strong, for long life.
Sirvene meets all these specifications, too.

Extreme care is necessary in making diaphragms,
because *thinnesses* of .010" to .020" are common.
No flaw, however minute, can be permitted.
A minor fault may mean the loss
of irreplaceable lives and expensive equipment.
Aircraft diaphragms should be precision built
by laboratory-type production methods,
and subjected to endless inspections.
That's the way Sirvene diaphragms are made.

But, perhaps, the most important factor
that contributes to Sirvene's extreme reliability,
is the superior engineering
which controls every phase,
from the development of the correct formula
to meet particular operating conditions,
to the finished product.
That's the reason why Sirvene is so dependable.

SINCE 1878

...The Chicago Rawhide Manufacturing Co. has specialized in the manufacture of Sirvis leather products for mechanical application. In 1929, Chicago Rawhide chemical engineers began a program of research, study and experimentation to develop elastomers which would operate efficiently under exceptional conditions. Sirvene was the result, and commercial production was begun in 1935. Sirvene was then, and has continued to be, the leader in its specialized field.

SIRVENE

THE *SCIENTIFIC* COMPOUNDED ELASTOMER

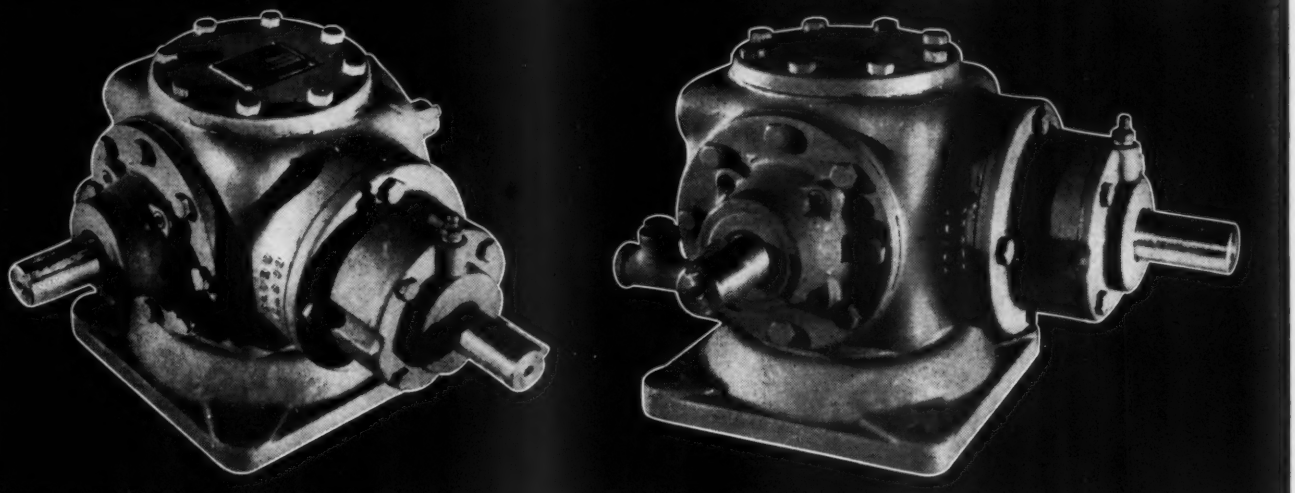
A Product of the Synthetic Rubber Division

CHICAGO RAWHIDE MANUFACTURING CO.

1305 Elston Avenue **Chicago 22, Illinois**

New York · Philadelphia · Detroit · Los Angeles · Cleveland · Norton
Pittsburgh · San Francisco · Cincinnati · Portland · Syracuse · Peoria

MITER GEAR UNITS



Boston Gear Standard miter gear units provide an efficient and compact means of transmitting motion at the same speed through right angles (around corners) and are furnished in sizes to convey 3/4 to 12 horsepower at 1200 R.P.M. Further, they can be supplied with the shaft projection vertically up or down or horizontally on three sides and, in addition, the base can be assembled on the unit for ceiling, side wall or horizontal mounting. These miter gear units are oil tight, they are equipped with case hardened steel spiral miter gears, and all shafts are mounted on ball bearings.

Any of the following authorized distributors and direct company branches will be pleased to give you complete specifications and prices of these Boston Gear Standard miter gear units:

AKRON, OHIO
Manufacturers Rubber & Supply Company
ALBANY, NEW YORK
Sager-Spuck Supply Co., Inc.
ALLENTOWN, PENNSYLVANIA
Wm. H. Taylor & Co., Inc.
ATLANTA, GEORGIA
J. M. Tull Metal & Supply Co.
BALTIMORE, MARYLAND
Carey Machinery & Supply Co.
BOSTON, MASSACHUSETTS
Chandler & Farquhar Co., Inc.
BRIDGEPORT, CONNECTICUT
Hawley Hardware Co.
BROOKLYN, NEW YORK
H. L. Dickie
BUFFALO, NEW YORK
Root, Neal & Co.
BURLINGTON, NORTH CAROLINA
Kester Machinery Co.
CANTON, OHIO
Manufacturers Rubber & Supply Company
CHARLOTTE, NORTH CAROLINA
Mathews-Morse Sales Co.
CHICAGO, ILLINOIS
Berry Bearing Co.
Boston Gear Works, Inc. (Branch)
Chicago Pulley & Shafting Co.
Power Transmission Equipment Company
CINCINNATI, OHIO
Queen City Supply Co.
CLEVELAND, OHIO
Boston Gear Works, Inc. (Branch)
Mau-Sherwood Supply Co.
DALLAS, TEXAS
Geo. J. Fix Co.
DAVENPORT, IOWA
Standard-Bearings Co.
DAYTON, OHIO
Klinger-Dills Co.
DENVER, COLORADO
Denver Equipment Co.
Western Belting & Packing Co.
DES MOINES, IOWA
Standard Bearings Co.
DETROIT, MICHIGAN
Chas. A. Strelinger Co.
EVANSVILLE, INDIANA
Bearings Service Co., Inc.
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Silliter-Holden, Inc.
HIGH POINT, NORTH CAROLINA
Kester Machinery Co.
INDIANAPOLIS, INDIANA
Indianapolis Belting & Supply Co.
Vonnegut Hardware Co.
JACKSONVILLE, FLORIDA
S. B. Hubbard Co.
KANSAS CITY, MISSOURI
Ellfedlt Machinery & Supply Co.
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Garrett Supply Co.
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Miami Parts & Spring Co.
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Western Iron Stores Co.
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NEWARK, NEW JERSEY
Squier, Schilling & Skiff
NEW BRITAIN, CONNECTICUT
Smith & Klebes, Inc.
NEW HAVEN, CONNECTICUT
C. S. Mersick & Co.
NEW ORLEANS, LOUISIANA
R. J. Tricon Co.
NEW YORK, NEW YORK
Morris Abrams, Inc.
L. C. Biglow & Co., Inc.
Boston Gear Works, Inc. (Branch)
Bronx Hardware & Supply Co.
NORTH QUINCY, MASS. (Main) (Office)
Boston Gear Works, Inc.
OAKLAND, CALIFORNIA
C. W. Marwedel
PEORIA, ILLINOIS
Illinois Bearing Co.
PHILADELPHIA, PENNSYLVANIA
Boston Gear Works, Inc. (Branch)
Maddock & Co.
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Somers, Fitler & Todd Co.
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Machine Parts Corp.
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Boston Gear Works, Inc. (Sls Ofc)
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TOLEDO, OHIO
The Ohio Belting & Transmission Company
TRENTON, NEW JERSEY
Wiley-Hughes Supply Co.
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Boston Gear Works, Inc. (Sls Ofc)
WATERBURY, CONNECTICUT
White Supply Co.
WINSTON-SALEM, N. CAROLINA
Kester Machinery Co.
WORCESTER, MASSACHUSETTS
W. M. Steele Co.

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CANADA, MONTREAL
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BOSTON GEARS

POST-WAR PLANS REALIZED!

SUCCESS IN ADVANCE . . . right now the future of many post-war products is being assured *well in advance* . . . For today more and more manufacturers are saying: "*Let's get in touch with Bridgeport Thermostat; let's incorporate Bridgeport bellows assemblies in our new designs.*"

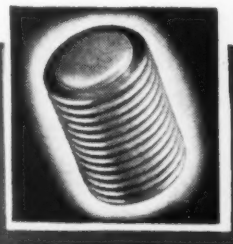
- **What is the result?**

First, Bridgeport Thermostat engineers study Mr. Manufacturer's proposed product . . . specify the size and type of bellows and bellows assembly required, basing their recommendations on exact operating conditions.

Next, the manufacturer, acting on Bridgeport Thermostat's report, either buys bellows and completes his assemblies in his own shop or has Bridgeport do the entire job. If he does the latter he receives bellows assemblies on schedule, built to exact specification . . . ready to install . . . *usually at a cost much lower than would have been possible in his own plant.*

Yes, Bridgeport technique is the secret ingredient in countless devices which will amaze the post-war world with their ingenuity and efficiency.

Write for Bulletin **NP**-100. It contains information of interest to everyone concerned with design and production of mechanical devices.



Bellows Assemblies . . . Bellows . . . Bellows Devices

BRIDGEPORT THERMOSTAT COMPANY, INCORPORATED—BRIDGEPORT 1, CONN.

The *New* Type Rotating and Stator Seals

"Spring-life" GYRO-SEALS

by COOK

Another reason why engineers and designers **"LOOK TO COOK"** *for new and improved components for their new and better products*

Gyro Seals, the most recent development emerging from the engineering laboratories of Cook Electric Company, is another of the many reasons why engineers and designers "Look to Cook" and "Spring-life" bellows, for the solving of their unusual engineering problems. The patented design of "Spring-life" bellows, their long life, and their adaptation in applications where heretofore bellows have been considered inadequate, is a story of interest to all men looking for new and improved methods and components. For the complete story of "Spring-life" bellows, send for this 44 page book, fully illustrated, showing the reasons why these bellows have, in so many instances, done the "impossible."

GYRO SEALS OFFER MANY ENGINEERING ADVANTAGES

Gyro Seal construction is new in design and new in principle. The constant spring-rate, inherent in the "Spring-life" bellows, makes the use of auxiliary springs unnecessary when Gyro Seals are used. Corrosion problems are readily overcome because "Spring-life" bellows can be made of all types of metals and the specific type of bellows is selected to suit conditions of each application.

Gyro Seals will operate on both external and internal pressure and have been built to withstand 5,000 lbs. p.s.i. They will operate in a range of from slower than 1 R.P.M. to faster than 10,000 R.P.M. Lapped finishes of sealing members can be furnished to within one light wave of flatness.

Gyro Seals after passing the most rigid laboratory tests, and after meeting more than the requirements expected of them in tests in the field, have truly become a worthy addition to the line of advanced "Spring-life" bellows products.

2700 SOUTHPORT AVENUE

COOK ELECTRIC Company

CHICAGO 14, ILLINOIS

STAND BACK, Paul Bunyan..

..Rough stuff like this takes ball bearings!

Out in the Pacific Northwest country the trees are even taller than the lumberjack's stories. Getting one of these monster Redwoods or Douglas Firs down is a job but nothing like the job of getting it up . . . and out. They have a machine out there for doing that which makes Paul's blue ox, "Babe", look like a yearling calf. It's a heavy-duty hoisting, towing rig for hooking up to the power take-off of a tractor. It'll pull up to 45,000 pounds at the rate of 79 feet a minute. And one of the features that enables this mechanical blue ox to handle several times the maximum capacity of the tractor itself is the use of large-ball, deep-groove Fafnir Ball Bearings. It takes this Fafnir "balanced design" to take this kind of rough-and-tumble shock.

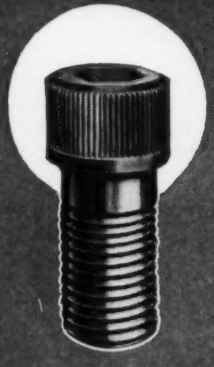
If that's the kind of bearing performance you want, then you want to talk with a Fafnir Field Engineer. Write us in detail today. The Fafnir Bearing Co., New Britain, Connecticut.

MOST COMPLETE LINE IN AMERICA

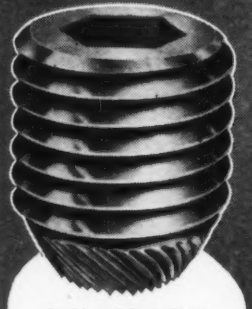
FAFNIR BALL BEARINGS

DESIGNERS *specify...*

KNURLED "UNBRAKO" SOCKET CAP SCREW



KNURLED "UNBRAKO" SOCKET SET SCREW



Pat'd and Pat's Pend.

UNBRAKO

REG. U.S. PAT. OFF

. . . for quality machinery and products

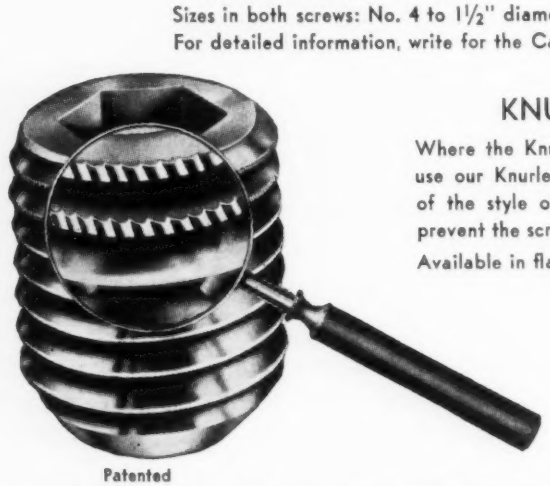
Great strength . . . Accuracy . . . Knurling—these features of "UNBRAKO" Socket Screws insure the more efficient service of any machine in which they are used.

The Socket Cap Screw shown at left above is preferred by mechanics because the knurling of its socket head affords a slip-proof grip for oily fingers — and fingers are the handiest of wrenches. The knurls therefore speed production by saving time.

The socket Set Screw shown at right above is an absolutely dependable Self-Locker—by virtue of its Knurled Cup-Point, which digs in when the screw is tightened as usual and holds tight. No amount of vibration will rattle it loose.

Sizes in both screws: No. 4 to 1½" diameter — Full range of lengths.

For detailed information, write for the Catalog of "UNBRAKO" Socket Screw Products.



Patented

KNURLED THREAD "UNBRAKO"

Where the Knurled Point "UNBRAKO" Set Screw cannot be used, use our Knurled Thread Set Screw — also a Self-Locker, regardless of the style of point. The knurls shown in cut at left positively prevent the screw from unwinding.

Available in flat, oval and dog points.

Knurling of Socket Screws originated with "Unbrako" years ago.

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNA. BOX 545

BRANCHES: BOSTON • DETROIT • INDIANAPOLIS • CHICAGO • ST. LOUIS • SAN FRANCISCO

OVER 40 YEARS IN BUSINESS

THIS CRYSTAL BALL TELLS US HOW TO MAKE ROLLS THAT FIT THEIR FUTURE

From long and varied roll-making experience Farrel-Birmingham engineers know in advance the requirements of rolls used in eighteen vital industries. Knowing these requirements, and using the facilities of *the largest specialty roll shop in America,* we are able to produce rolls that fit individual needs exactly.

Growing up with these eighteen industries, we have met their changing roll problems. This has not been easy. At one end of the list is the paper industry, requiring, for example, reverse coating rolls round and straight to within one-half of one ten-thousandth inch, or giant calender rolls twenty-five feet in length having a perfectly graduated increase in diameter from ends to center of sixty thousandths of an inch, ground with a high finish.

In direct contrast are the rolls required for crushing and grinding sugar cane. Here a special metal mixture is used to produce a hard iron of open grain and rough texture. Cane sugar factories depend on the gripping and feeding capacity of their rolls to provide maximum extraction.

The rolls used in producing metal sheet and strip must combine a smooth, hard surface with adequate strength to withstand the strains, stresses and impact shocks encountered in this service. For the processing of rubber, plastics, ink, paint, grain, cereals and other products there are other requirements. And so it goes—each industry with different needs, different specifications.

When you need rolls, remember that we can make them—to fit your requirements exactly. Write for information about rolls for specific applications, or for details of any of the other products illustrated below.

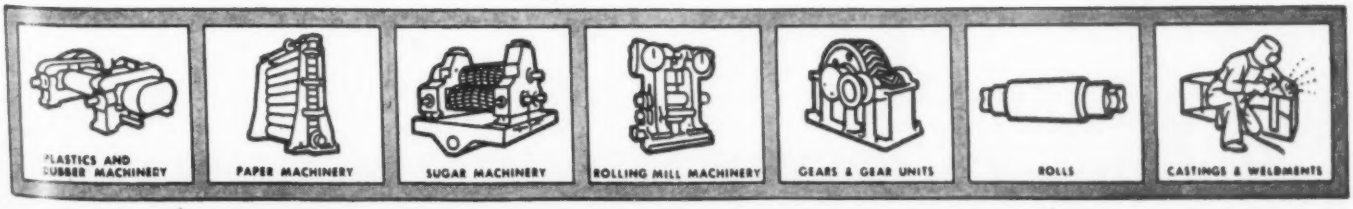
FARREL-BIRMINGHAM COMPANY, INC. • ANSONIA, CONN.

Plants: Ansonia, Derby and Stonington, Conn., Buffalo, N. Y.

Sales Offices: Ansonia, Buffalo, New York, Pittsburgh, Akron, Los Angeles, Tulsa, Houston, Charlotte.

Farrel-Birmingham

FB 225



Proved IN WAR
Preferred IN PEACE

Prior to the war, manufacturers preferred to use Perkins Gears in their respective products for the same reason that they now prefer to use them in the war materiel they are producing to rigid Government specifications: Perkins has the necessary facilities and skill to produce precision gears in any quantity and to meet any specifications that the best and very latest types of machine tools under the supervision of New England craftsmen can turn out. Need anything more be said?

LET'S GET TOGETHER ON YOUR WAR OR POST-WAR NEEDS

PERKINS MAKES:

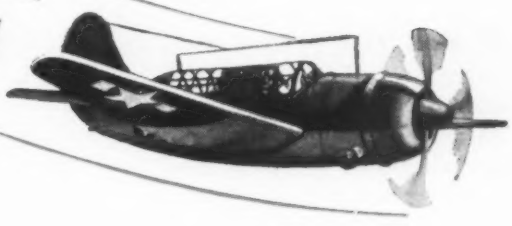
Helical Gears	*Bevel Gears*	*Ratchets*
Worm Gears	*Spiral Gears*	*Spur Gears*

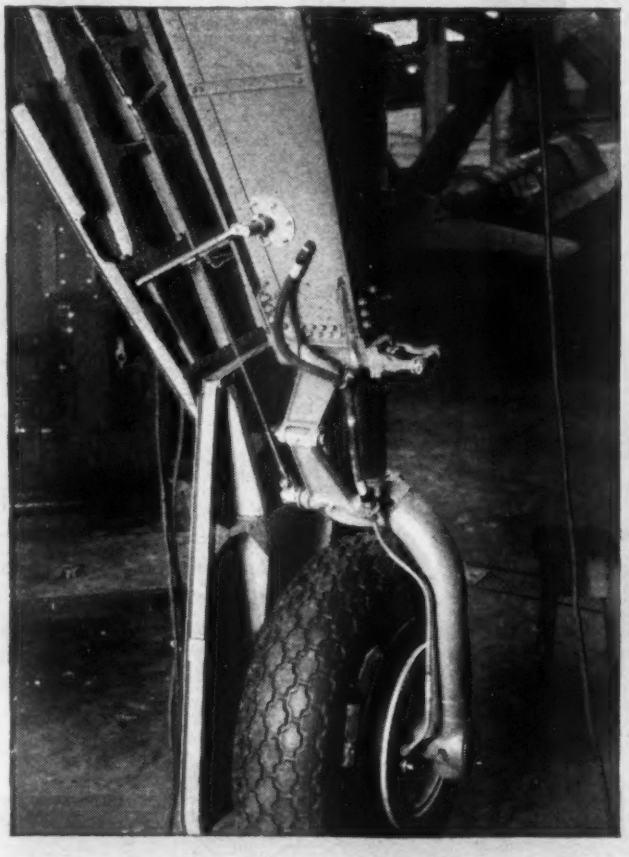
Ground Thread Worms

PERKINS *custom-cut* GEARS

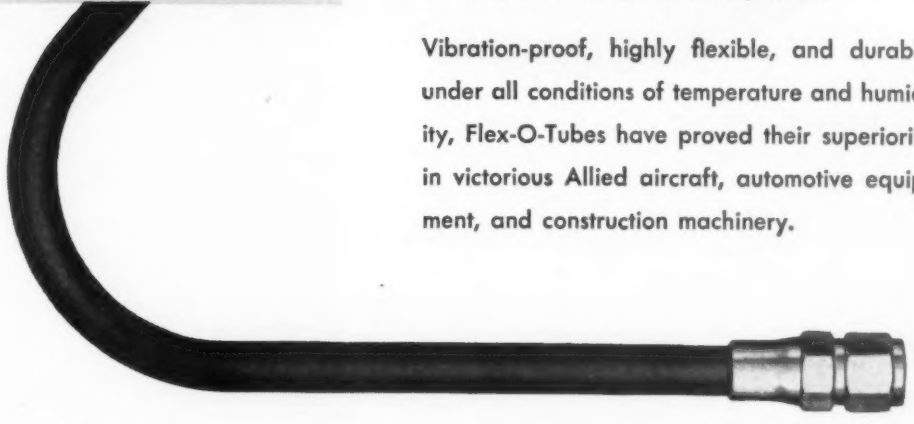
PERKINS MACHINE & GEAR CO., SPRINGFIELD 2, MASS.

HELLDIVERS MUST STRAIN





Landing gear of Curtiss-Wright Helldiver showing Flex-O-Tube assembled for hydraulic brakes. (Photo courtesy Canadian Car & Foundry Co.)



FLEX-O-TUBES in the vaunted Curtiss-Wright Helldiver withstand the terrific strain of dive-bombing runs and help to provide the extra measure of reliability that has made the Navy's air wing the scourge of enemy fleets.

Vibration-proof, highly flexible, and durable under all conditions of temperature and humidity, Flex-O-Tubes have proved their superiority in victorious Allied aircraft, automotive equipment, and construction machinery.

Let Flex-O-Tube Engineers, with many years of experience in designing hose assemblies for specific applications, assist you in your wartime and postwar problems.

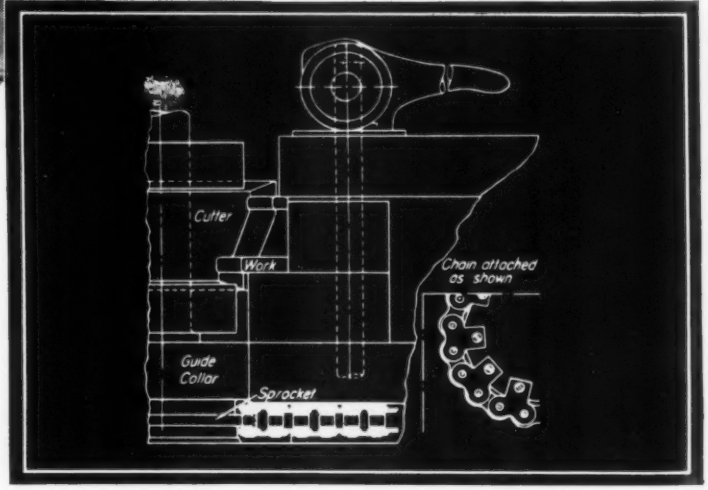
THE **Flex-O-Tube** COMPANY

LAFAYETTE at 14th AVE., DETROIT 16, MICHIGAN
Offices: CHICAGO · FORT WORTH
LOS ANGELES · NEW YORK
SEATTLE · TORONTO, ONT.

USING THE *Usual* TO SOLVE THE *Unusual!*

① UNUSUAL APPLICATIONS of usual methods of transmitting power, timing operations, or moving materials have often been the solution to many a tough engineering puzzle. Baldwin-Rex roller chain belts, a standard solution, have solved unusual as well as usual problems.

② IN THIS WOOD SHAPER they are used to revolve the irregular form containing the work to be shaped. An unusual application—but here again the inherent possibilities of Baldwin-Rex roller chain belts provided an ideal answer to a perplexing problem.



③ THE CHAIN IS APPLIED as shown in this diagram. It is fitted around the base of the form and fastened by screws extending through standard M-35 attachment links. Work is revolved by the feed sprocket engaging the chain rollers. Air pressure holds the form in contact with the guide collar. The next time you are faced with an unusual problem, investigate the usual problem-solving abilities of Baldwin-Rex roller chain belts.

For catalogs on Baldwin-Rex roller chain belts or competent information on your specific drive problems, write **BALDWIN-DUCKWORTH** *Division of* **CHAIN BELT COMPANY,** *321 Plainfield Street, Springfield 2, Mass.*

BALDWIN-REX *ROLLER CHAIN BELTS*

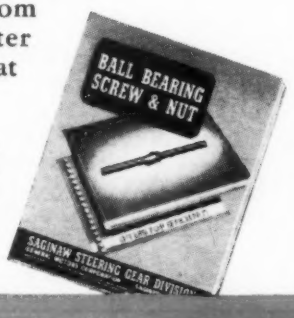
Baldwin-Duckworth Division, Springfield 2, Massachusetts • Rex Chain Belt and Transmission Division, Rex Conveyor and Process Equipment Division, Milwaukee 4, Wisconsin

Saginaw BALL-BEARING SCREW AND NUT

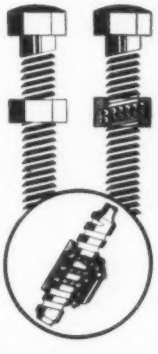
The Saginaw Recirculating Ball-Bearing Screw and Nut offers revolutionary friction-free operation, introducing new efficiency to unlimited applications. Moving smoothly on rolling balls inserted between the threads of the nut and the screw, it boosts actuating efficiency to 90% and up, for the first time in the science of screw mechanics.

The Saginaw Ball-Bearing Screw and Nut is designed to assist in any problem of elevating or lowering, opening or closing, expanding or retracting. It has been successfully applied to retracting airplane landing gears, operation of bomb-bay doors, and movement of wing flaps on planes. It can be applied as well to milling machines and lathes as a lead screw, a jack or a control mechanism. Freedom from friction permits greater speeds without excessive heat generation . . . permits savings in power and weight of the motor drive . . . and reduces operating cost as much as two-thirds.

Years of experimentation in the development of the recirculating ball-bearing steering gear for automobiles lie behind the perfection of the Saginaw Ball-Bearing Screw and Nut. There may be an application in your products. Our engineering department will be pleased to give your problem special attention.



Write for free descriptive booklet on your company letterhead. Department 25-PE-5 Saginaw Steering Gear Division, Saginaw, Michigan.



THE PRINCIPLE—In the ordinary nut and bolt, power is consumed by friction caused by the threads riding on each other (left). To ease friction and thus decrease actuating effort, Saginaw Steering Gear devised a means of inserting bearing balls between the threads connecting the nut and bolt (right), and developed a method of permitting the balls to recirculate through a special raceway (see inset). Operating effort is cut two-thirds; efficiency climbs to 90 per cent or more. Power may be applied to either the screw or the nut—however torque is applied, transmission of power is positive, uniform, smooth.

KEEP BUYING WAR BONDS

Saginaw Steering Gear

DIVISION, GENERAL MOTORS CORPORATION, SAGINAW, MICHIGAN.

MANUFACTURER OF STEERING GEAR ASSEMBLIES, STEERING LINKAGE ASSEMBLIES, UNIVERSAL JOINTS AND PROPELLER SHAFTS, DIESEL ENGINE AND AIRCRAFT PARTS.

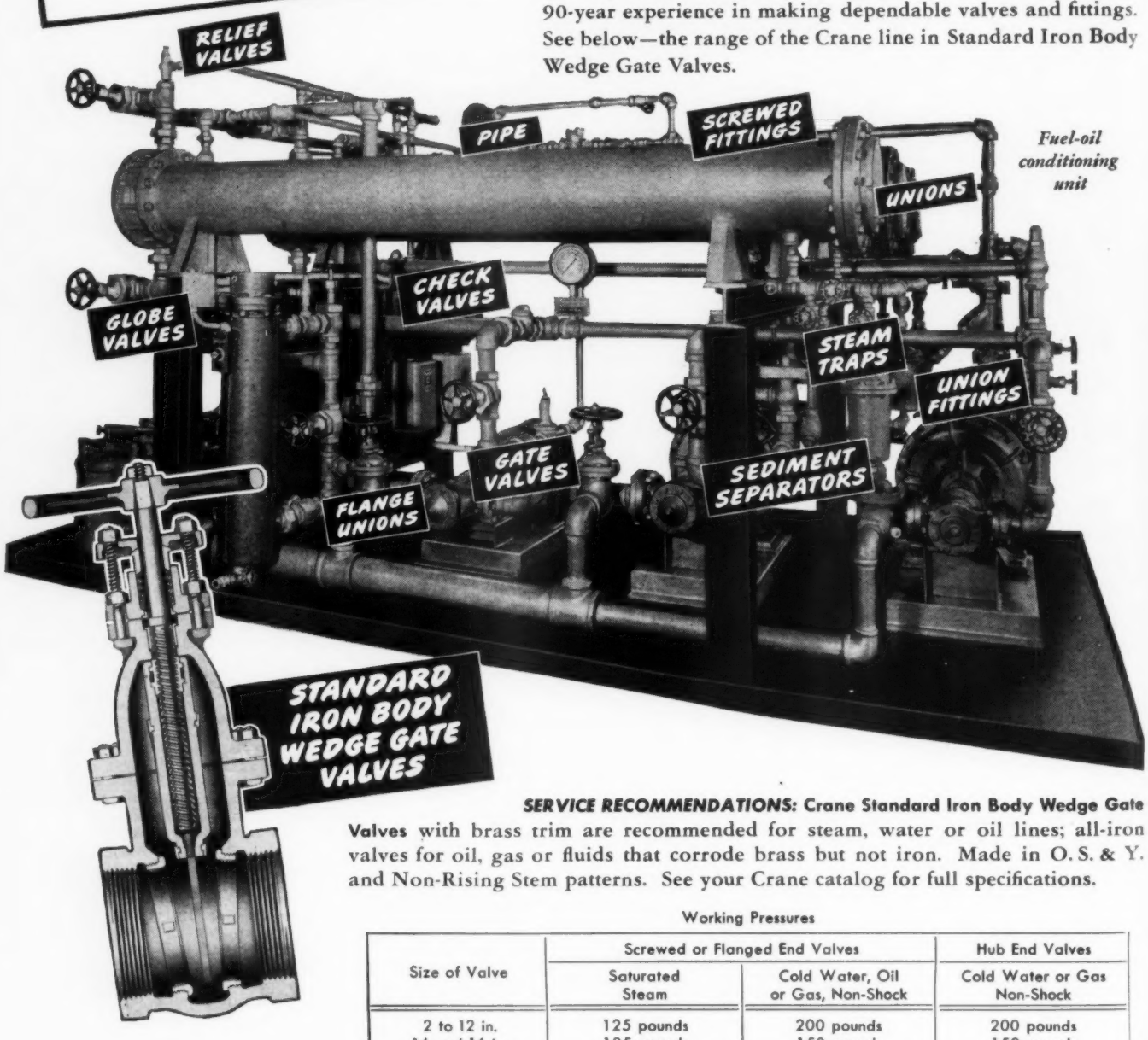
Piping Equipment Headquarters For Product Designers

ONE STANDARD OF QUALITY

ONE RESPONSIBILITY

ONE SOURCE OF SUPPLY

When specifying piping equipment for your design, consider what the complete Crane line offers. It saves your time . . . it assures your getting exactly what you need, be it for a simple lubricating hook-up or a complex processing system. You choose from the world's greatest line of piping materials—in brass, iron and steel—all uniform in quality and backed by single responsibility. Your design gets the benefit of Crane Co.'s 90-year experience in making dependable valves and fittings. See below—the range of the Crane line in Standard Iron Body Wedge Gate Valves.



Fuel-oil conditioning unit

SERVICE RECOMMENDATIONS: **Crane Standard Iron Body Wedge Gate Valves** with brass trim are recommended for steam, water or oil lines; all-iron valves for oil, gas or fluids that corrode brass but not iron. Made in O. S. & Y. and Non-Rising Stem patterns. See your Crane catalog for full specifications.

Working Pressures

Size of Valve	Screwed or Flanged End Valves		Hub End Valves
	Saturated Steam	Cold Water, Oil or Gas, Non-Shock	Cold Water or Gas Non-Shock
2 to 12 in.	125 pounds	200 pounds	200 pounds
14 and 16 in.	125 pounds	150 pounds	150 pounds
18 to 24 in.	*	150 pounds	150 pounds

*For steam lines larger than 16-in., Crane 150-Pound Cast Steel Gate Valves are recommended. (For sizes under 2-in., use Crane Clamp Gate Valves.)

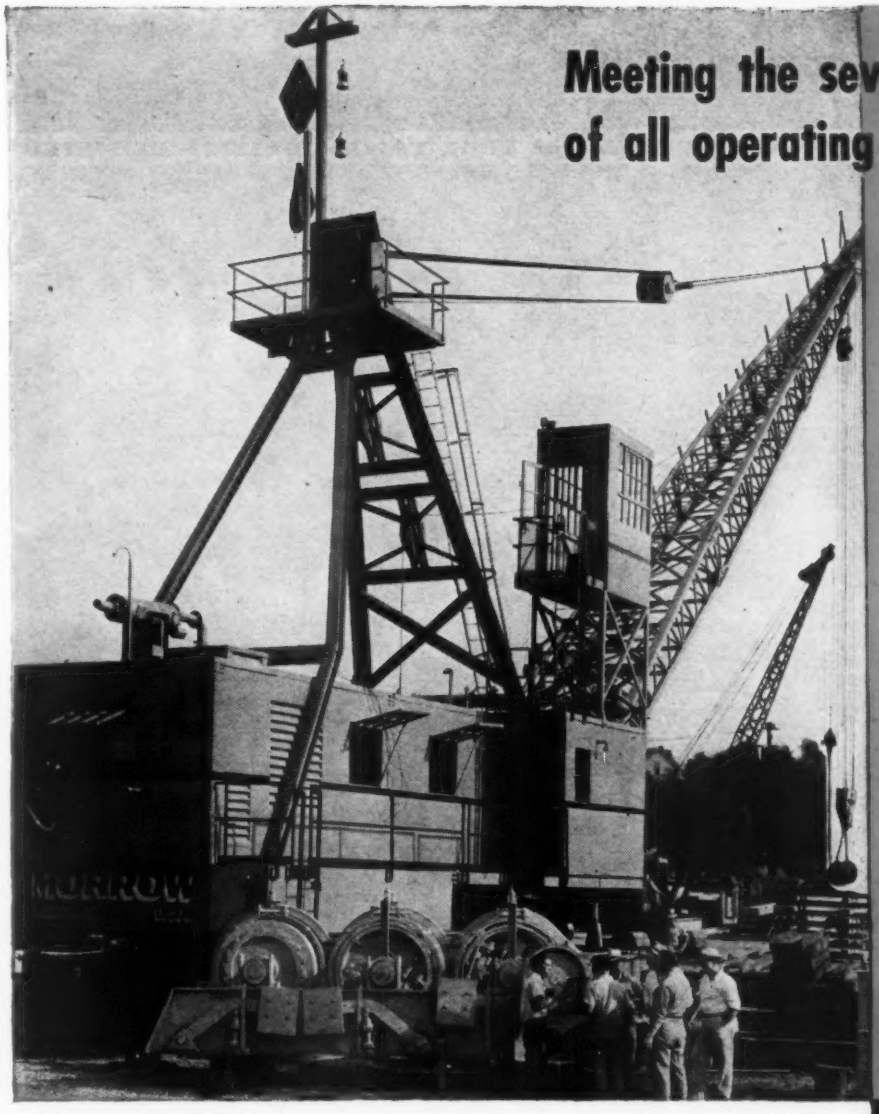
CRANE CO., General Offices: 836 S. Michigan Ave., Chicago 5, Ill. • *Branches and Wholesalers Serving All Industrial Areas*

CRANE

90 YEARS OF PROGRESS 1855 1945

VALVES • FITTINGS • PIPE

PLUMBING • HEATING • PUMPS



Meeting the severe requirements of all operating sheaves in

30-TON MORROW CRANES

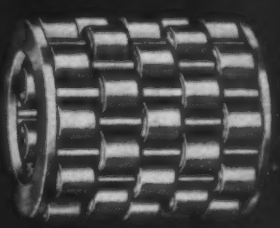
These giant 30-ton Cranes were built by the Morrow Mfg. Co., for the U. S. Army Transportation Corps. Specifications required a test at 25% overload, which was easily met by the Cranes and by the twenty-five Orange Staggered Roller Bearings used in the operating sheaves of each Crane. All Cranes are undergoing severe service in foreign lands.

Frankly, Orange Staggered Roller Bearings are "too good" for many conventional applications. But where loads are extremely heavy—where operating conditions are unusually severe—or where even, precision running is absolutely essential, Orange Stagger Roller Bearings serve at their best.

Because of their exclusive design, Orange Staggered Roller Bearings have much higher load carrying capacity—do the work of larger size conventional bearings. Thus, you can carry the required load with smaller bearings where space is limited. Or, use them equal size for ample overload capacity and extra life hours expectancy.

The advantages of Orange Staggered Roller Bearings may be had in a full range of standard, **interchangeable** sizes. Special sizes made to order. Meanwhile, send the coupon for detailed Engineering Data Book, showing design, sizes, capacities, installation data, etc.

ORANGE "STAGGERED" ROLLER BEARINGS



SEND FOR ENGINEERING DATA TODAY!

ORANGE ROLLER BEARING COMPANY, Inc.
551 MAIN STREET ORANGE, NEW JERSEY

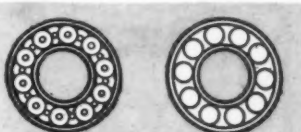
Please send me your Staggered Roller Bearing Data Book

NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

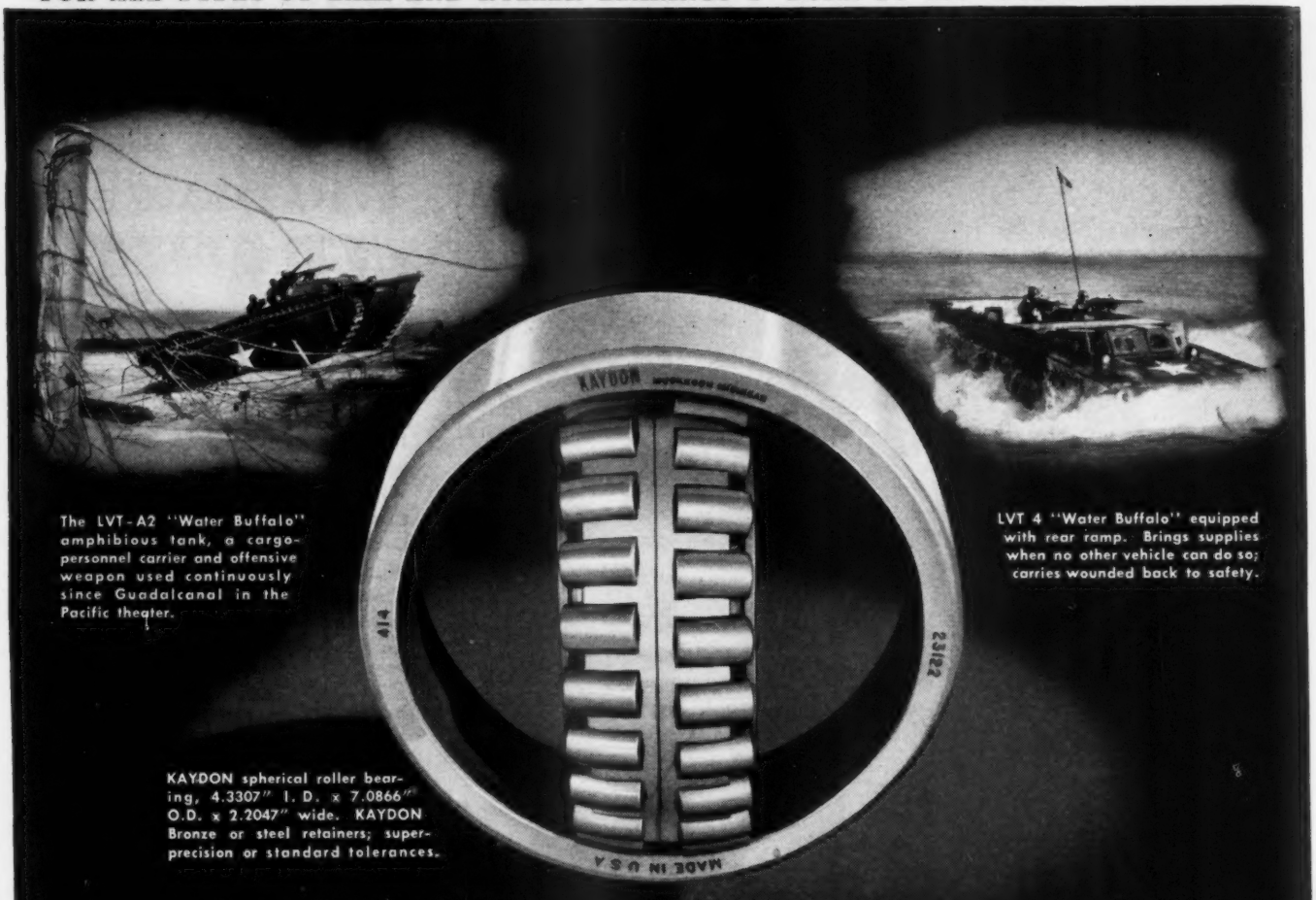
CITY_____ STATE_____



Shown above are end views of an Orange Staggered Roller Bearing and a conventional roller bearing. Note how staggered roller design provides a multiplicity of contact points within the loaded zone.

Contact KAYDON *of Muskegon*

FOR ALL TYPES OF BALL AND ROLLER BEARINGS 4" BORE TO 120" OUTSIDE DIAMETER



The LVT-A2 "Water Buffalo" amphibious tank, a cargo-personnel carrier and offensive weapon used continuously since Guadalcanal in the Pacific theater.

LVT 4 "Water Buffalo" equipped with rear ramp. Brings supplies when no other vehicle can do so; carries wounded back to safety.

KAYDON spherical roller bearing, 4.3307" I. D. x 7.0866" O.D. x 2.2047" wide. KAYDON Bronze or steel retainers; super-precision or standard tolerances.

BUFFALO- *ing the* JAPS

WATER BUFFALOS . . . by Food Machinery Corporation, Riverside, California

BEARINGS . . . by KAYDON of Muskegon, Michigan

HEROES . . . by U. S. Army, Navy and Marines

☆ ☆ ☆

KAYDON Bearings serve the machines of the U. S. Armed Forces in many ways, on many fronts. KAYDON is proud of its part in speeding victory.

Specializing in the production of all types and sizes of ball and roller bearings in diameters up to 120", KAYDON offers a service that banishes the need for compromising on a "standard" bearing that does not fill your exact needs.

In addition, KAYDON offers atmospheric control in heat-treating, rarely provided by special bearing manufacturers; flame hardening, precision heat-treating, metallurgical laboratories, microscopy and physical testing.

Capacity available for production of all types and sizes of KAYDON Bearings.

KAYDON *Types of Standard or Special Bearings:*
Spherical Roller • Taper Roller
Ball Radial • Ball Thrust
Roller Radial • Roller Thrust

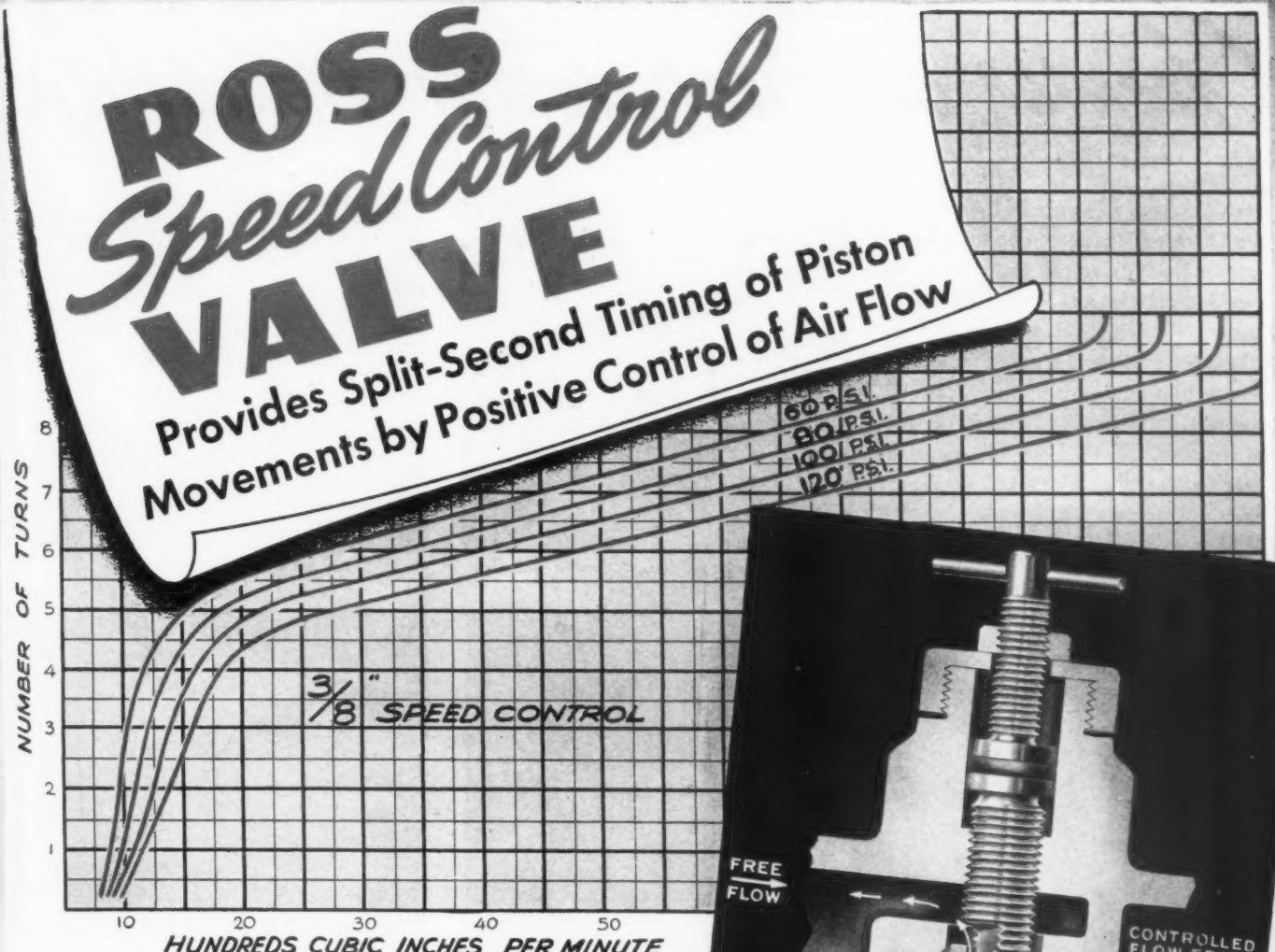
THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

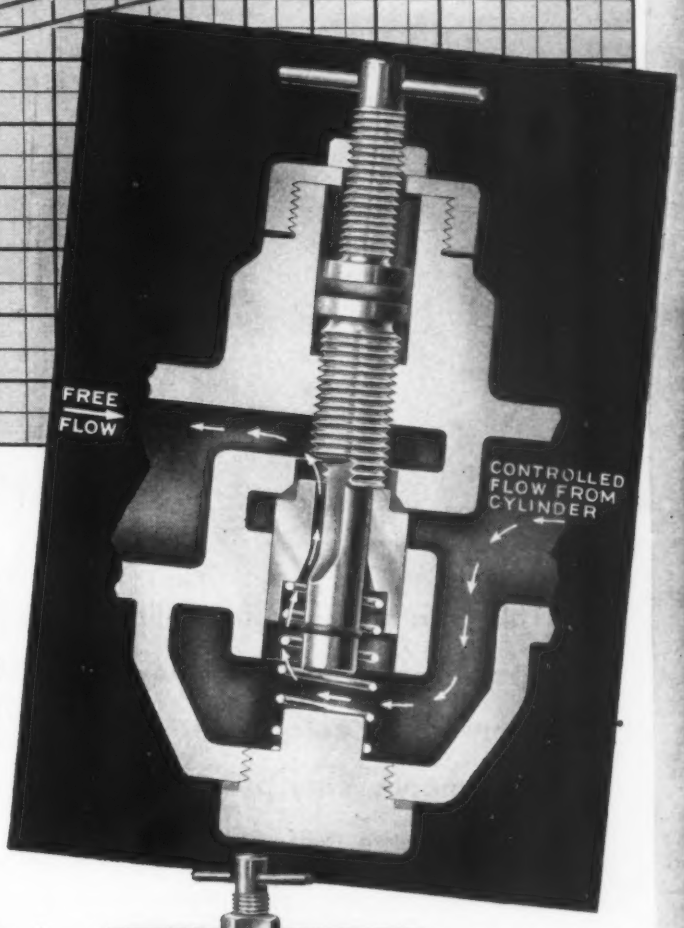
New in Name . . . Old in Experience

ROSS Speed Control VALVE

Provides Split-Second Timing of Piston Movements by Positive Control of Air Flow



Available in sizes 1/4", 3/8", 1/2" and 3/4"



With air flow regulated by screw action, changes in volume take place with constant progression—not a series of "steps"—but with micrometer accuracy. Control of the air flow is absolute—from zero to maximum.

Simple—dependable—rugged. Only two moving parts—stem and poppet.

Write for bulletin which gives information on different sizes and applications.

ONLY 2 MOVABLE PARTS

- **STEM**
- **POPPET**

ROSS Air Control VALVES

THE BRIDLE FOR AIR HORSEPOWER

ROSS Operating VALVE CO.

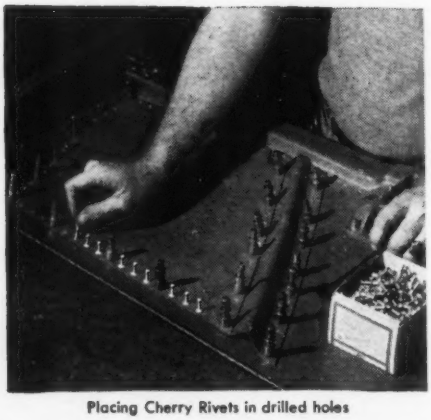
6495 Epworth Boulevard
DETROIT 10, MICHIGAN

Greater product design flexibility

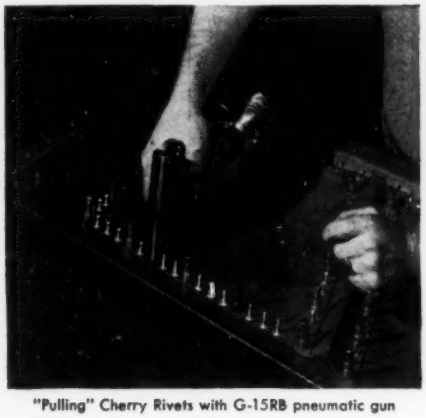
Here's a clear example of how Cherry Blind Rivets allow designing up to maximum efficiency rather than down to previous mechanical limitations. With Cherry Rivets, this assembly was strengthened with a plate, simply and quickly (the entire installation took 12 minutes). Without Cherry Rivets, a less satisfactory, slower, more expensive form of reinforcing would have been necessary.

PHOTOS COURTESY OF LOCKHEED AIRCRAFT CORPORATION

The cover plate stiffener makes this a blind application

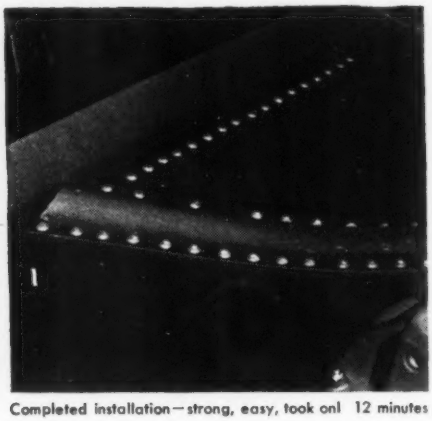


Placing Cherry Rivets in drilled holes



"Pulling" Cherry Rivets with G-15RB pneumatic gun

Trimming stems flush to Cherry Rivet head



Completed installation—strong, easy, took onl 12 minutes

This greater design flexibility results from such factors as these: Cherry Rivets upset from one side of any spot, blind or not, without any bucking. Small, lightweight Cherry Rivet guns reach hard-to-get-at spots easily and quickly. The smooth, easy pull with which Cherry Rivets are upset allows their use in soft or brittle materials as well as all sheet metals. Exceptional shank expansion allows hole size variations up to .008". Material thicknesses may vary as much as .062" for the same grip length rivet. (Both of these are factory-recommended tolerances. Even greater variations are possible.) Installed Cherry Rivets have shear values comparable with solid rivets.

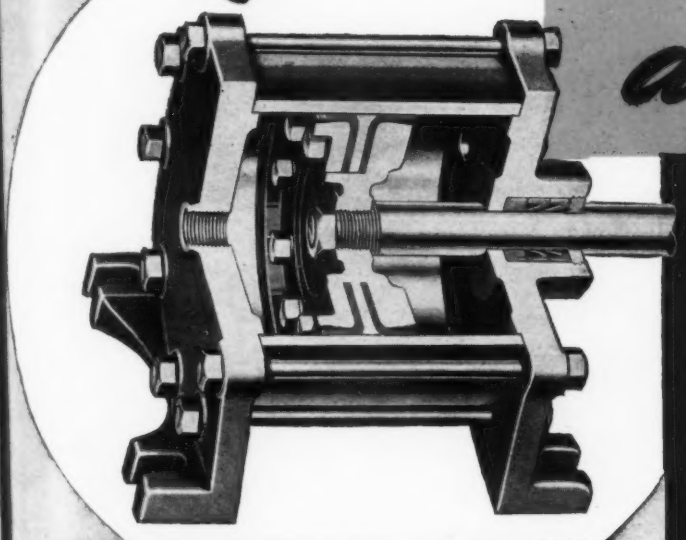
For more detailed information, write now for illustrated Manual D-45, Dept. A-106, Cherry Rivet Company, 231 Winston Street, Los Angeles 13, California.

CHERRY RIVETS, THEIR MANUFACTURE & APPLICATION ARE COVERED BY U. S. PATENTS ISSUED & PENDING

Cherry Rivet
Company
LOS ANGELES 13, CALIFORNIA

Replace Inefficient Hand and Mechanical Operations..

Get FAST-ACTING, POSITIVE, CONTROLLED POWER at Low Cost...

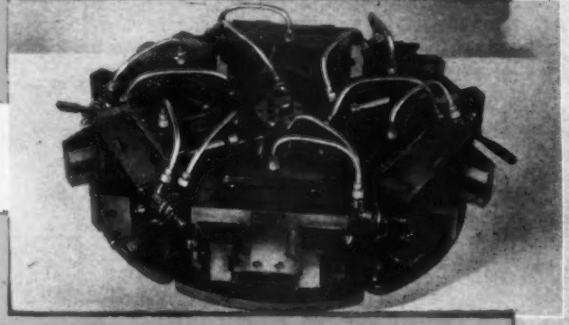


with Logan NON-ROTATING AIR CYLINDERS

FOR • PUSHING • PULLING • LIFTING HOLDING and OTHER APPLICATIONS

These Logan Features Assure Peak Performance and Long Life

- Quicker response obtained through larger ports.
- Higher pressures permitted by more sturdy construction; heavy duty nickel-chrome iron covers. Bronze bushing supports and aligns piston rod.
- Cylinders can be furnished with cushioning at one or both ends to eliminate shock at end of stroke.
- Maximum power without leakage assured by molded composition packing cups, self-adjusted by air.
- Permanent seal around rod provided by sea ring packing, self-adjusted by air.



To get fast-acting, convenient power for pushing, pulling, lifting and holding operations, replace inefficient hand actuation with *standard* LOGAN Air Cylinders. Many profitable advantages can be obtained that will increase production in industrial applications of all kinds.

The constant power with follow-up assures positive, uniform actuation. Control valves may be located at any convenient point, adjacent or remote. Important savings in operator time and fatigue will result. In addition, the use of LOGAN Air Cylinders often permits simplifying the design of a mechanical structure and reducing amount of floor space required.

LOGAN Air Cylinders are available in 7 types of mounting to fit almost every requirement; interchangeable end covers permit a wide range of combination mountings. Manufactured in sizes from 1½" to 24" bore, with any length of stroke up to 18 feet. Recommended for operation at pressures up to 150 p.s.i.

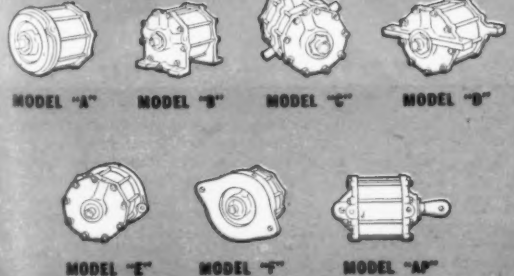
ENGINEERING ADVICE . . .

Write for recommendations on the proper cylinders for your applications and most effective methods of installation. No obligation.

USE COMPLETE LOGAN AIR EQUIPMENT . . .

For highest efficiency, use Logan equipment throughout in your complete air installations. Logan cylinders, control valves and air accessories are designed to work together as a balanced air system.

LOGAN AIR CYLINDERS ARE AVAILABLE IN 7 STANDARD MOUNTING TYPES



ARMY E NAVY

FREE CATALOGS FOR YOU

Logan

Air and Hydraulic Equipment

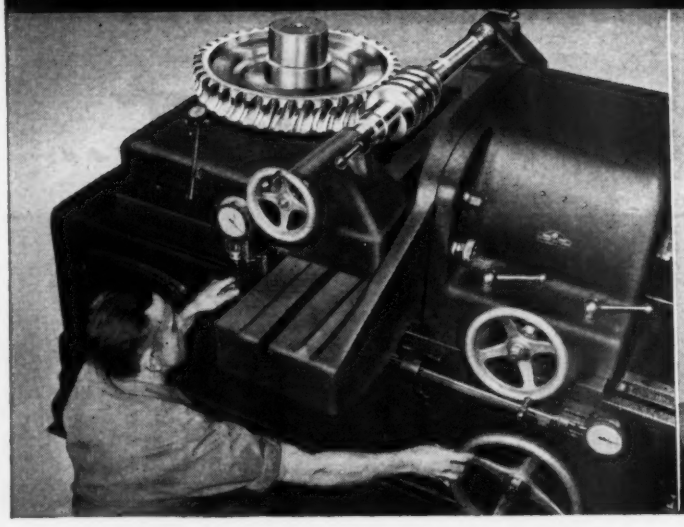
LOGANSPORT MACHINE CO., INC.

811 PAYSON RD
LOGANSPORT
INDIANA

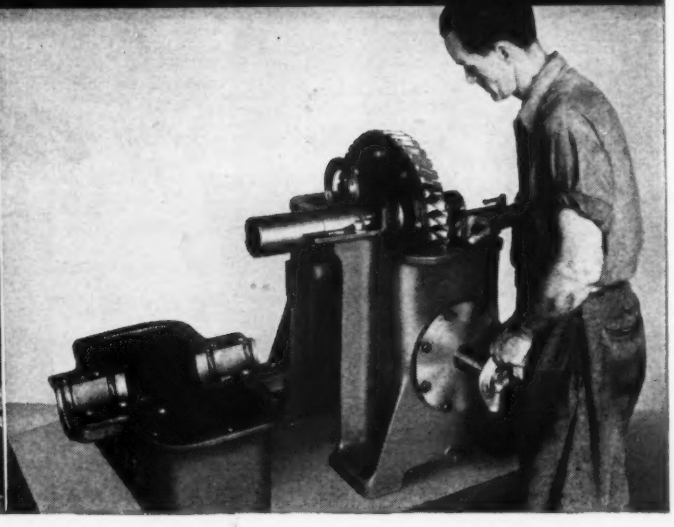
CHUCKS • CYLINDERS • VALVES • PRESSES • SURE FLOW COOLANT PUMPS

Write for complete information on LOGAN Air Cylinders, control valves and air accessories...also other items in the LOGAN line which can help you.

CHECKED for TOOTH CONTACT



1.—Checking tooth contact with worm and gear located at exact center distances, checked to within 1/10,000th of an inch.



2.—Checking tooth contact by means of "bearing blue" after assembly.

BOTH BEFORE and AFTER ASSEMBLY

Before assembly, every De Laval Worm Gear is tested on the machine shown at the left, in which it is accurately mounted with the center line of the gear and the center line of the worm correctly spaced and at true right angles. Under these conditions the tooth contact is observed and the back lash accurately measured.

After assembly in the gear case, tooth contact is re-checked by means of bearing blue to assure correct adjustment. Such checking and holding center distances within close limits assures satisfactory operation of De Laval Worm Gear Speed Reducers, and facilitates installation when De Laval Worm and Gear sets are purchased for use in other machinery.

Specifications alone do not make a worm gear.

1147

TURBINES • HELICAL GEARS and WORM GEAR SPEED REDUCERS CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS and COMPRESSORS • IMO OIL PUMPS

WORM GEAR DIVISION

DE LAVAL

STEAM TURBINE COMPANY · TRENTON 2, NEW JERSEY

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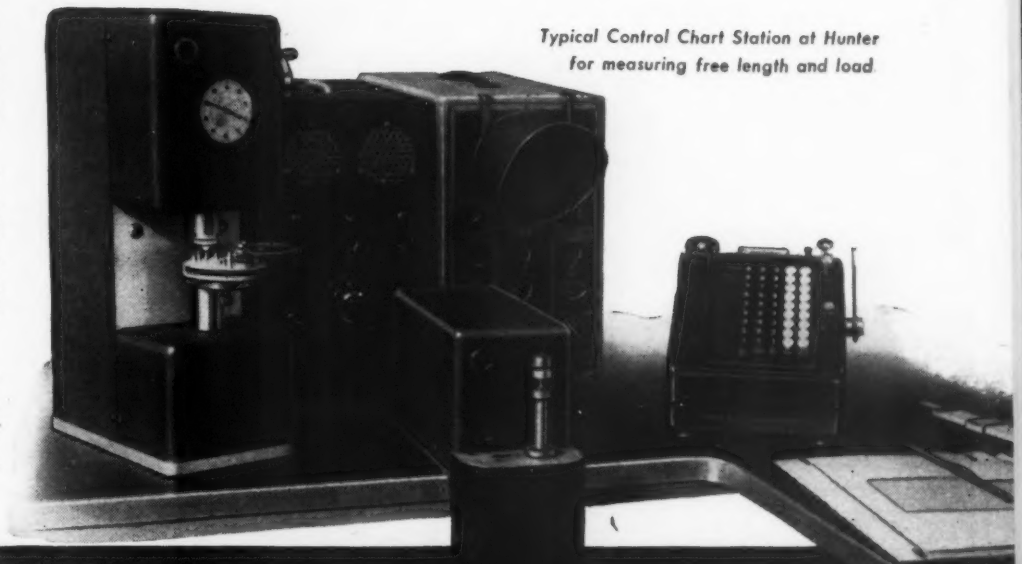
Flow Chart for Quality Control

Efficient control over the quality of precision springs requires active and intelligent application of statistical methods, using testing and measuring devices possessing accuracy and speed standards unheard of less than three years ago.

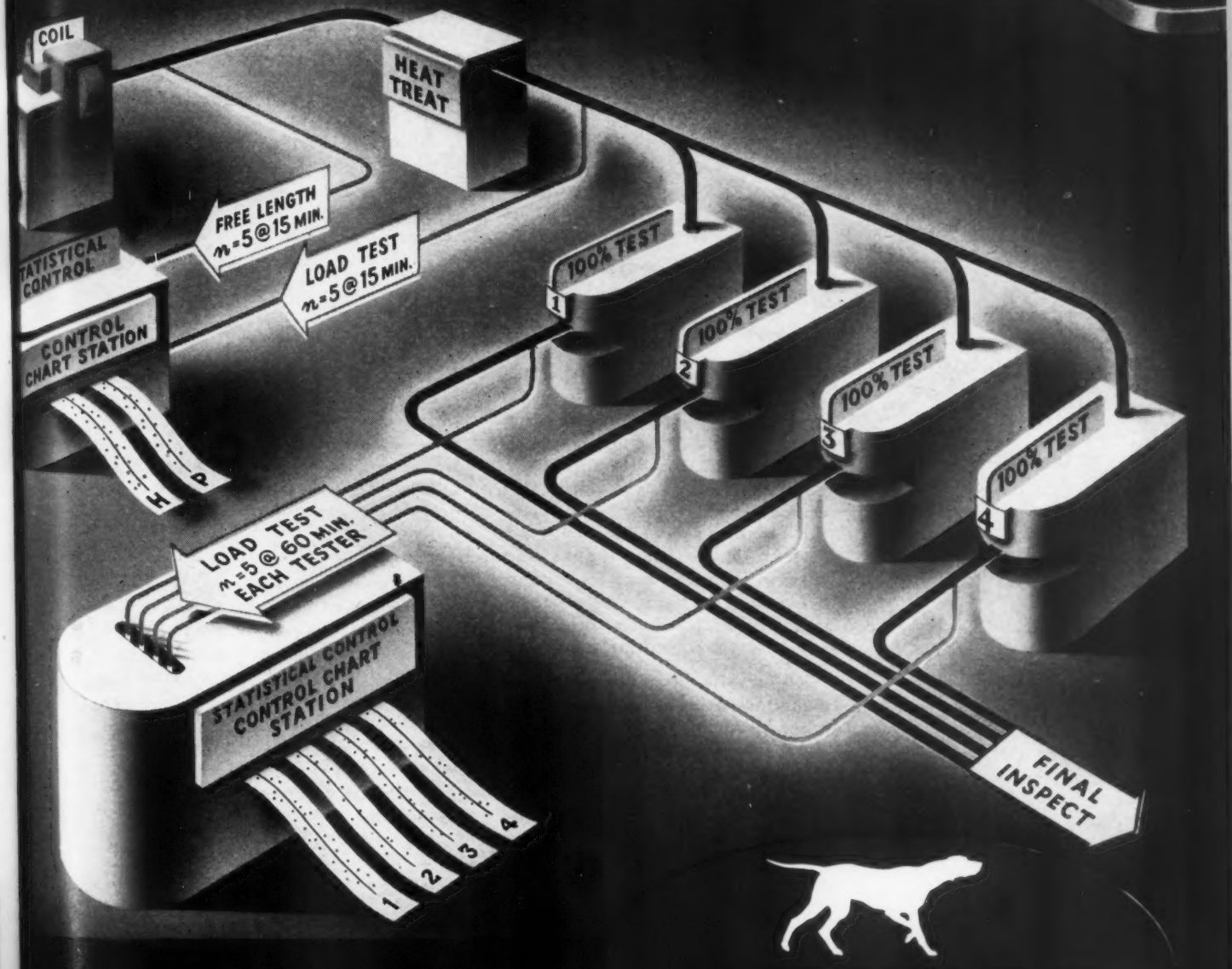
These new inspection techniques have been in full use at Hunter for some time.

The development and manufacture of our own new electronically-operated devices reached such proportions that we had to create a new "Special Apparatus" department to handle the work.

Below, you see how the quality function ties into the manufacturing cycle. The artist's drawing is based on an actual flow chart for close tolerance compression springs.

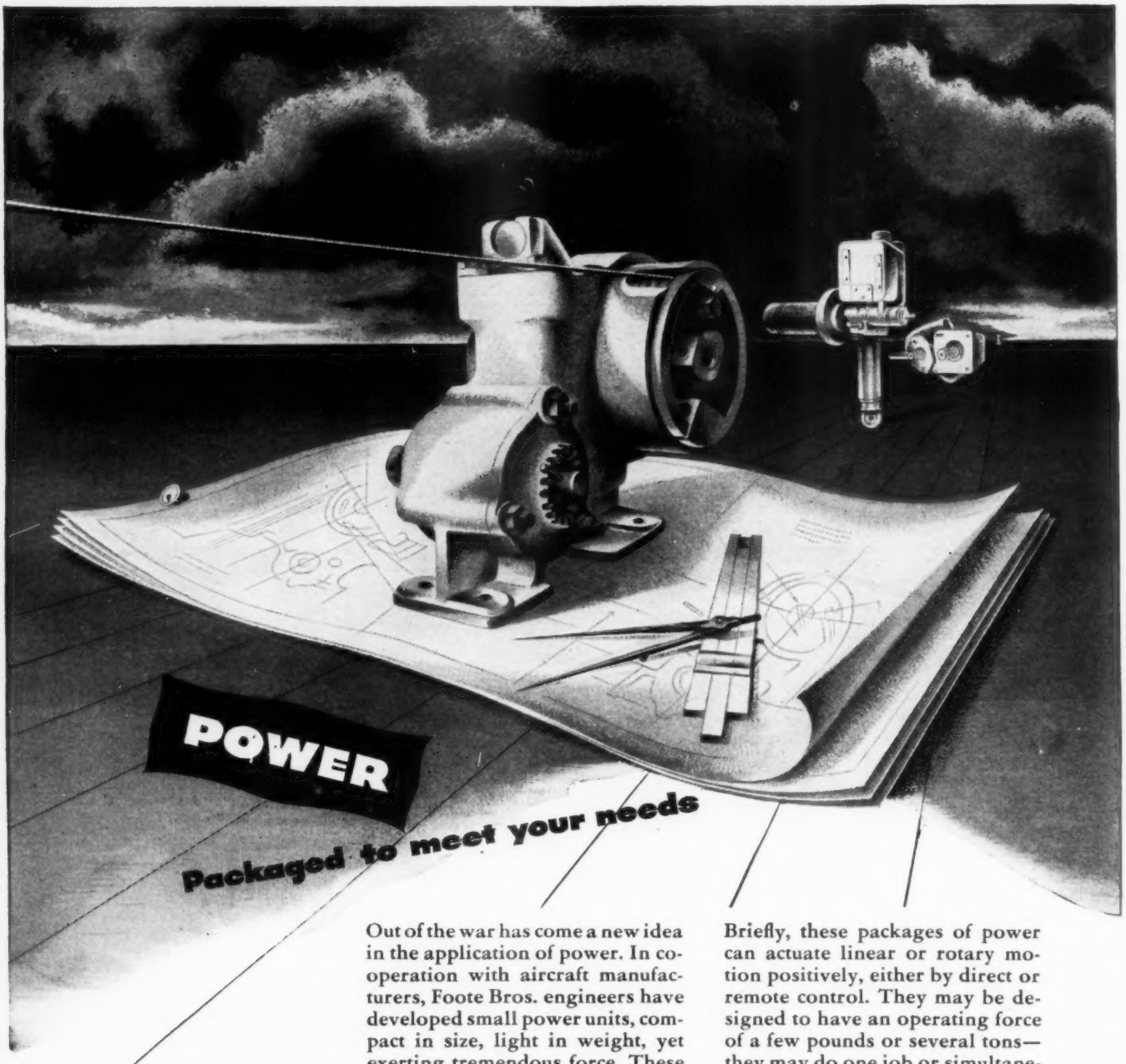


Typical Control Chart Station at Hunter for measuring free length and load



ITER PRESSED STEEL COMPANY, LANSDALE, PENNA.

Springs, Metal Stampings, Wire Forms, Mechanical and Electrical Assemblies.



Out of the war has come a new idea in the application of power. In cooperation with aircraft manufacturers, Foote Bros. engineers have developed small power units, compact in size, light in weight, yet exerting tremendous force. These power units are designed for accessory drives and to open and close ventilators, trim stabilizers, operate wing flaps, and perform many other jobs that otherwise would have to be done manually.

Right now in development in the laboratories at Foote Bros. are other applications of these power units—applications on peacetime machines and equipment—that will mean more efficient operation—that will result in definite competitive advantages.

Briefly, these packages of power can actuate linear or rotary motion positively, either by direct or remote control. They may be designed to have an operating force of a few pounds or several tons—they may do one job or simultaneously perform many.

For the machines or equipment you are manufacturing or planning to manufacture, Foote Bros. power units may assure you greater operating efficiency, more compact design, lighter weight, or better engineering. They may simplify your design problems and even make a design practical that without them would be impractical.

Foote Bros. engineers will gladly discuss the application of power units to your equipment.

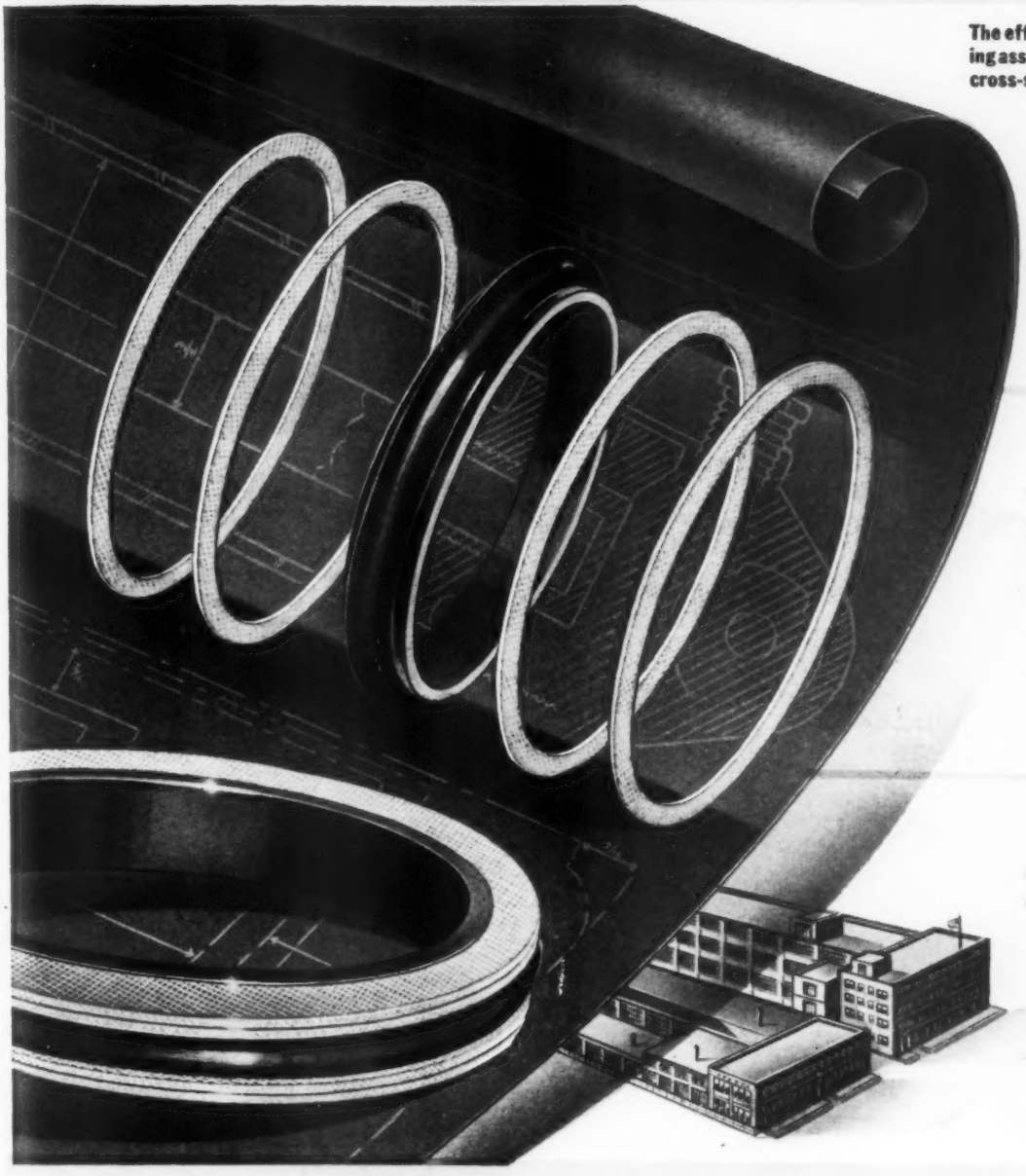
A copy of this informative product engineering manual on "A-Q" gears will be sent to you on request.

FOOTE BROS. GEAR AND MACHINE CORPORATION, Dept. W, 5225 S. Western Blvd., Chicago 9, Ill.

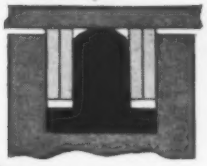
FOOTE BROS.

Better Power Transmission Through Better Gears

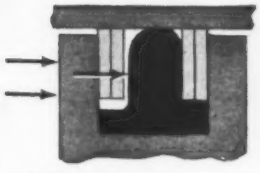
Improved WEATHERHEAD T-RING PACKING



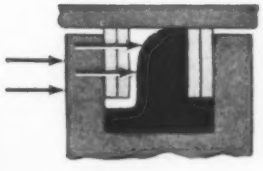
The efficiency of the T-ring Packing assembly is shown by the three cross-sectional panels below.



1 Packing before pressure is applied. Note clearance between the flanges and the guard rings.



2 Packing upon immediate application of pressure which swells the flange under the farther guard ring and against cylinder wall.



3 Full application of pressure. Guard rings are held tightly against cylinder wall — no binding or jamming.

Look Ahead with

Weatherhead

THE WEATHERHEAD COMPANY, CLEVELAND 8, OHIO
Plants: Cleveland, Columbia City, Ind., Warsaw, Ind., Los Angeles
Canada — St. Thomas, Ontario

The problem of properly sealing fluids in many types of machines is an important one. The new, improved Weatherhead T-ring Packing, recently patented, meets the requirements for both standard and special applications. This seal is available in two types and in sizes varying from ½ inch to 4 inch O. D. For information or literature write or phone any Weatherhead branch office.

BRANCH OFFICES: NEW YORK • PHILADELPHIA • DETROIT • CHICAGO • ST. LOUIS • LOS ANGELES

GEROTOR HAS ALL 3 PRESSURE RANGES

300# HYDRAULIC, OIL OR WATER CYLINDER

1500# HYDRAULIC, OIL OR WATER CYLINDER

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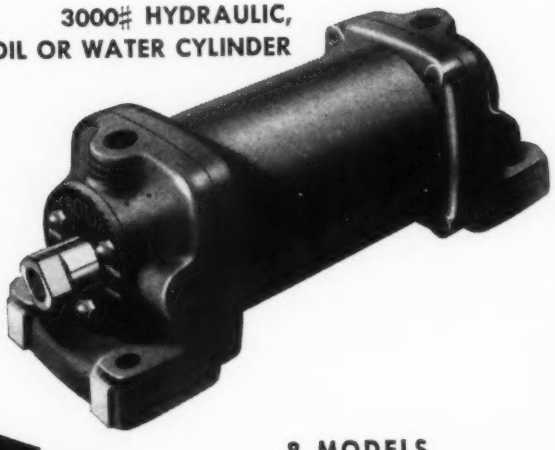

8 MODELS
12 DIAMETERS
ANY STROKE

GEROTOR
AIR and HYDRAULIC DEVICES

LOGANSPORT, INDIANA

GEROTOR MAY CORPORATION • PLANTS—BALTIMORE, MARYLAND • LOGANSPORT, INDIANA

THE SOCKET SCREW
TO TURN TO WHEN

A HEX WON'T TURN FURTHER

. . . because only BRISTO "Multiple-Spline" keeps going after a hex quits

Don't get us wrong. Bristol has nothing against Hex socket screws . . . makes and sells a lot of them. A Hex is good as long as you keep it in its place.

But in products with hard-to-reach fastening points . . . in products exposed to severe vibration . . . in products that require frequent disassembly . . . it's the Bristo "Multiple-Spline" Socket Screw that belongs.

The spline-shaped key meshing accurately with the spline-shaped socket provides a rotary pull, instead of the expanding push that makes Hex sockets round out or burst when they've reached their limit. That's why you'll find an extra turn or two of extra tightness in the Bristo "Multiple-Spline" and why you can release it with a flick of the key instead of a tug.

Bristo "Multiple-Spline" Socket Screws come in cap and set screw styles in sizes down to and including No. 4 wire.

And remember, if it's Hex Socket Screws you need, you get the same cold-forged toughness and precision manufacturing that make "Multiple-Spline" first choice for the tight places.

BRISTO SET & CAP SCREWS

WHY "MULTIPLE-SPLINE" MEANS

TIGHTER

NO EXPANDING PRESSURE; THE KEY PULLS THE SCREW AROUND

GET SPECIFIC FACTS ON BRISTO "MULTIPLE-SPLINE" FOR YOUR APPLICATION

☐ cream separators
☐ dental equipment
☐ die cutting and stamping machinery
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☐ electric razors
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☐ elevators
☐ generators
☐ hydraulic machines
☐ instruments
☐ machine tools
☐ match machinery
☐ meat machinery
☐ meters
☐ oil well machinery
☐ paper mill machinery
☐ portable electric tools
☐ postage meters
☐ printing presses
☐ pumps
☐ punches
Other applications .....
Name .....
Company .....
Address .....
☐ radios
☐ refrigerators
☐ screw machines
☐ textile machinery
☐ time clocks
☐ vacuum cleaners
☐ vending machines
☐ washing machines
☐ adding and computing machines
☐ addressing machines
☐ air compressors
☐ air conditioning apparatus
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☐ aviation metal parts
☐ blowers
☐ cameras
☐ cash registers

THE BRISTOL COMPANY
Mill Supply Division
121 Bristol Rd., Waterbury 91, Conn.

Please send me literature describing Bristo "Multiple - Spline" Socket Screws. I'm interested in the following applications.

Only the B LINE has the right socket screw for every application

The BRISTOL Company
MILL SUPPLY DIVISION

"MULTIPLE-SPLINE" CAP SCREWS No. 4 to 1½"
"MULTIPLE-SPLINE" SET SCREWS No. 4 to 1½"
"HEX" CAP SCREWS No. 4 to 1"
"HEX" SET SCREWS No. 4 to 1"
"HEX" STRIPPER BOLTS ¼" to ¾"
"HEX" PIPE PLUGS ¼" to 1"
"MULTIPLE-SPLINE" and "HEX" KEYS

GEARS

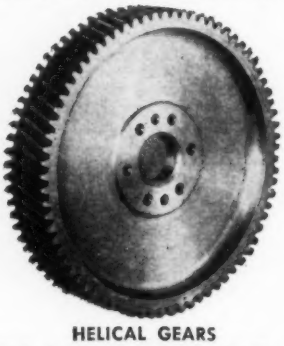
FOR INDUSTRY

D.O.JAMES gears are products of an organization with over 57 years of gear making experience. Our extensive and unexcelled gear cutting facilities enable us to capably handle modern industry's gear requirements.

CONTINUOUS-TOOTH HERRINGBONE GEARS
The continuous-tooth 30° helix angle herringbone gear with a backbone has many advantages and are produced in a size range from 1″ to 60″ in diameter, 16 DP to 1 ½ DP and up to an 18″ face.

SPIRAL BEVEL GEARS
Cut in a size range from 1″ to 30″ in diameter. 24 DP to 1 ½ DP.

SPUR GEARS
Precision made gears. In a very extensive range from ¾″ to 150″ in diameter and 32 DP to ¾ DP and up to 30″ face.



HELICAL GEARS
Made from 1 to 60 inches in diameter and from 24 DP to 1 ½ DP. Our helical gear cutting department is capable and extensive.

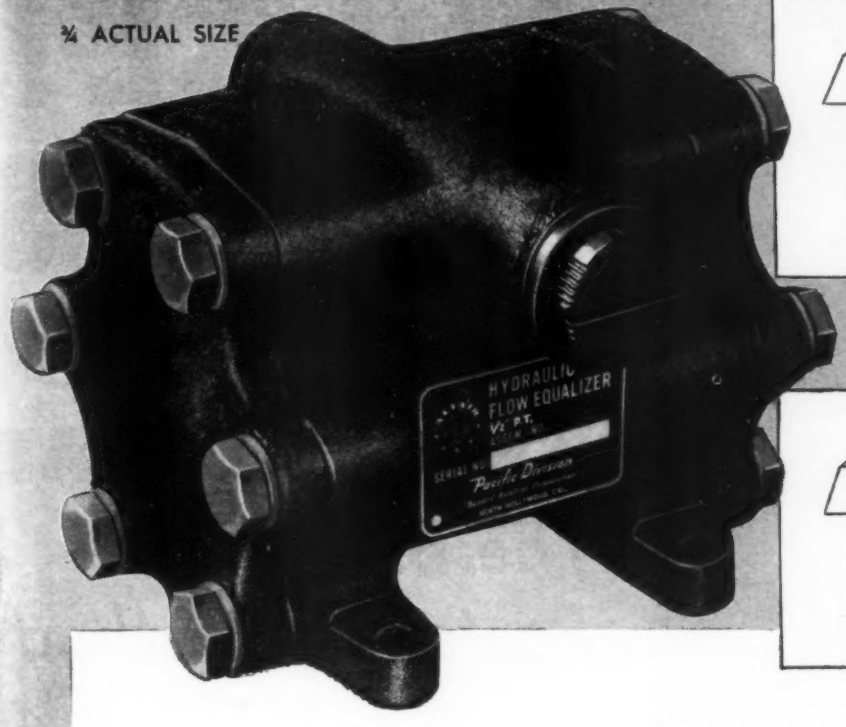
BEVEL GEARS
(Straight tooth) made from 1 inch to 60 inch in diameter and from 24 DP to ¾ DP. Precision made and of highest quality.

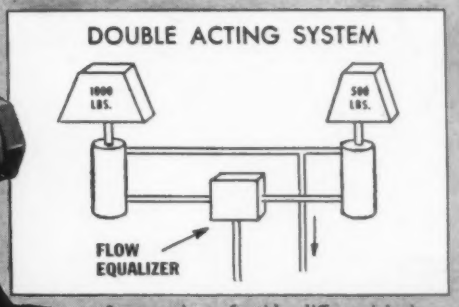
WORM GEARS
Gear teeth are generated on tangential feed hobbing machines by tapered and ground hobs. We make worm gears from 1″ to 100″ in diameter and from 24 DP to 1 DP.

D.O.James

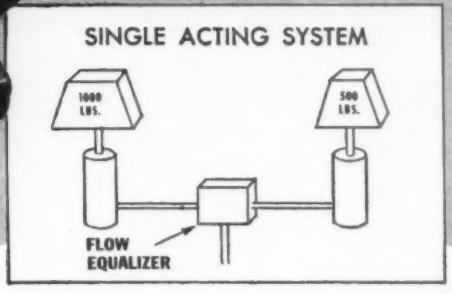
Established 1888

D.O.JAMES MANUFACTURING CO.
1140 W. MONROE STREET · CHICAGO, U. S. A.





Irrespective of wide differentials in loads or restriction the Bendix Equalizer synchronizes action in *both* directions. Although the ram at left is doing twice the work—both rams travel at equal speed for their entire strokes.



EQUAL RAM SPEED, REGARDLESS OF LOAD WITH THE BENDIX FLOW EQUALIZER

Now . . . you can equalize the speed of two unevenly loaded hydraulic rams, in both directions—raising or lowering—with the Bendix Flow Equalizer. All outside adjustments have been eliminated . . . the metering is automatic and foolproof.

The Bendix Hydraulic Flow Equalizer eliminates the necessity for mechanical interconnection or for two pumps. The installation is simple and inexpensive . . . merely replace the "T" in the pressure line from the control valve with the Equalizer to accomplish full synchronization of the hydraulic rams.

A special proportioner version of the unit is available which will split the flow into two lines with proportional flows greater in one line than the other. Operated in the reverse direction it will *combine* two such uneven flows, constantly maintaining the specified proportion between the two lines.

The Equalizer shown is the ½" P. T. size and will handle flows of from 2 GPM to 8 GPM. Wire or write for Bulletin BA-100 containing complete installation and performance data. Our engineering department is available to confidentially assist you on any hydraulic problem.

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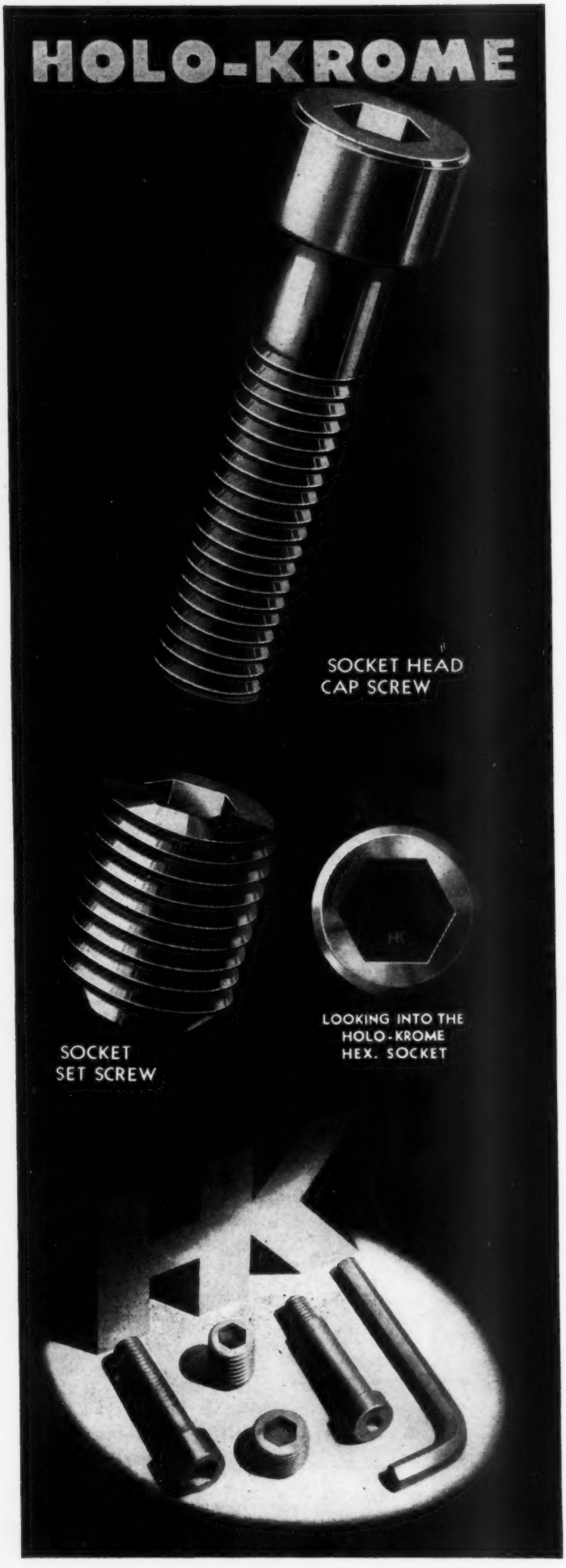
• MANUFACTURERS OF A COMPLETE LINE OF HYDRAULIC EQUIPMENT FOR INDUSTRY •

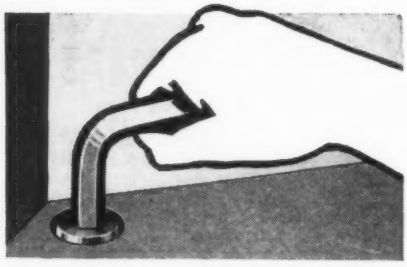


SOCKET SCREWS

by

HOLO-KROME

The BETTER Fastening Method



INTERNAL WRENCHING QUICK AND POSITIVE

War-time applications—the most severe of proving grounds—prove the many advantages and the unfailing performance of Holo-Krome FIBRO FORGED Socket Screws—the Completely Cold Forged Screws . . . For the better fastening method specify "HOLO-KROME".

HOLO-KROME

fibro-forged **SOCKET SCREWS**

Manufactured exclusively by

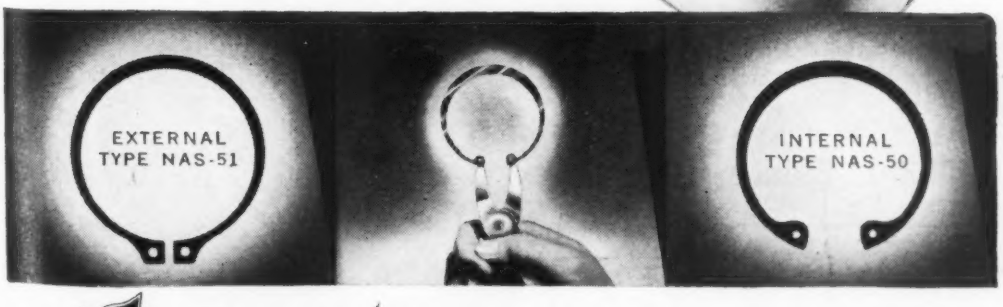
THE HOLO-KROME SCREW CORP.

HARTFORD 10, CONNECTICUT, U. S. A.

WALDES TRUARC RETAINING RINGS

U. S. PATENT RE 19,144

Waldes Truarc expands or contracts without distortion and without permanent set, fitting tight all around the groove. It offers important advantages over shoulders, nuts, collars, etc., for all thrust-load fixings in shaft and housing applications. It saves space, weight, assembly time and machining costs. Waldes Truarc presents a significant advance in retaining rings, well worth your thorough investigation. We will gladly furnish samples and full data for tests, upon request.



- Internal type National Aircraft Standard 50.
- External type National Aircraft Standard 51.

WALDES KOHINOOR, INC. Long Island City 1, N. Y.

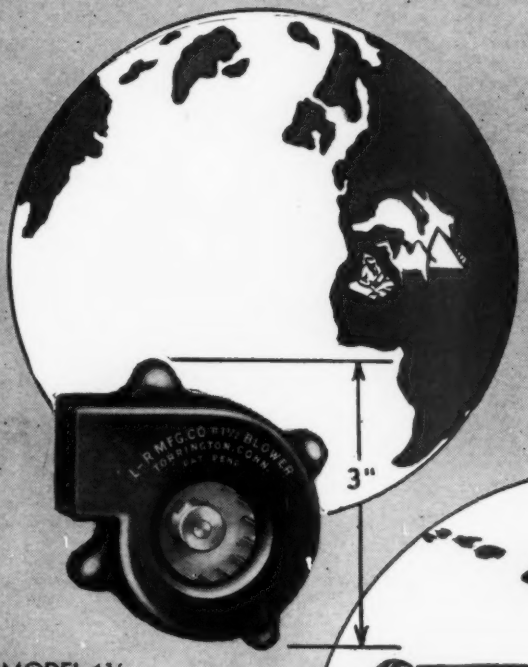
Canadian Representatives: Prence Progress & Engineering Corp., Ltd., 72-74 Stafford St., Toronto

Under all temperature and climatic conditions

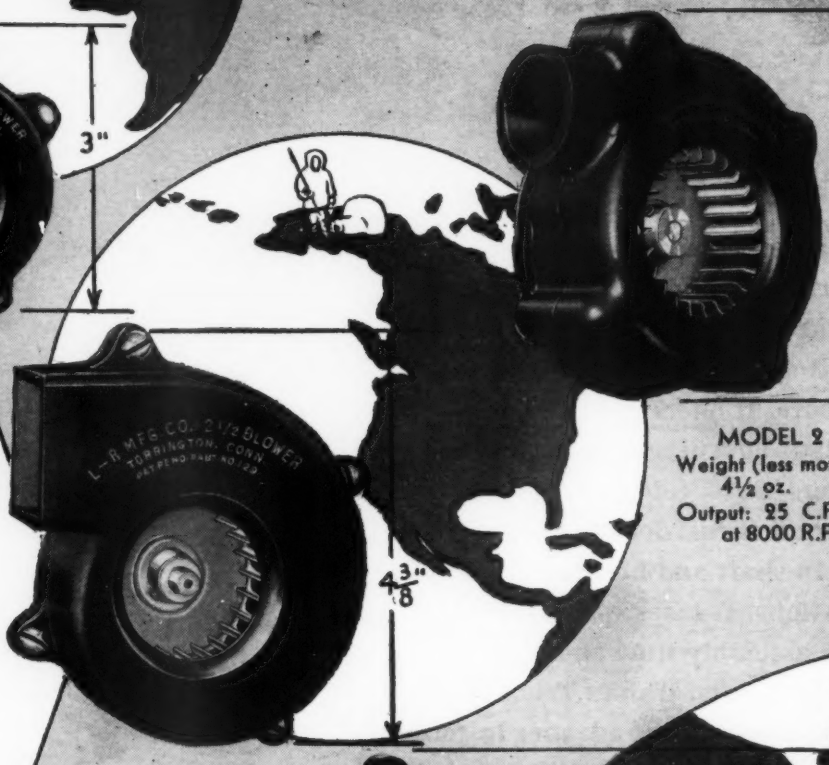
L-R BLOWERS

give maximum heat dispersion

LIGHT - COMPACT - EFFICIENT



MODEL 1½
Weight (less motor): 2 oz.
Output: 15 C.F.M. at 8000 R.P.M.

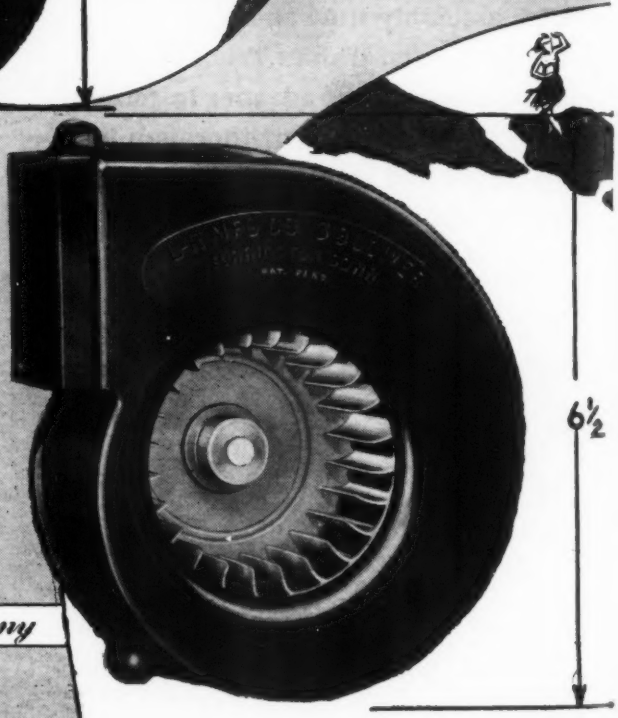


MODEL 2
Weight (less motor): 4½ oz.
Output: 25 C.F.M. at 8000 R.P.M.

It's New!

MODEL 2½
Weight (less motor): 4 oz.
Output: 50 C.F.M. at 8000 R.P.M.
Height: 4½"

MODEL 3
Weight (less motor): 12 oz.
Output: 260 C.F.M. at 8000 R.P.M.
Height: 6½"



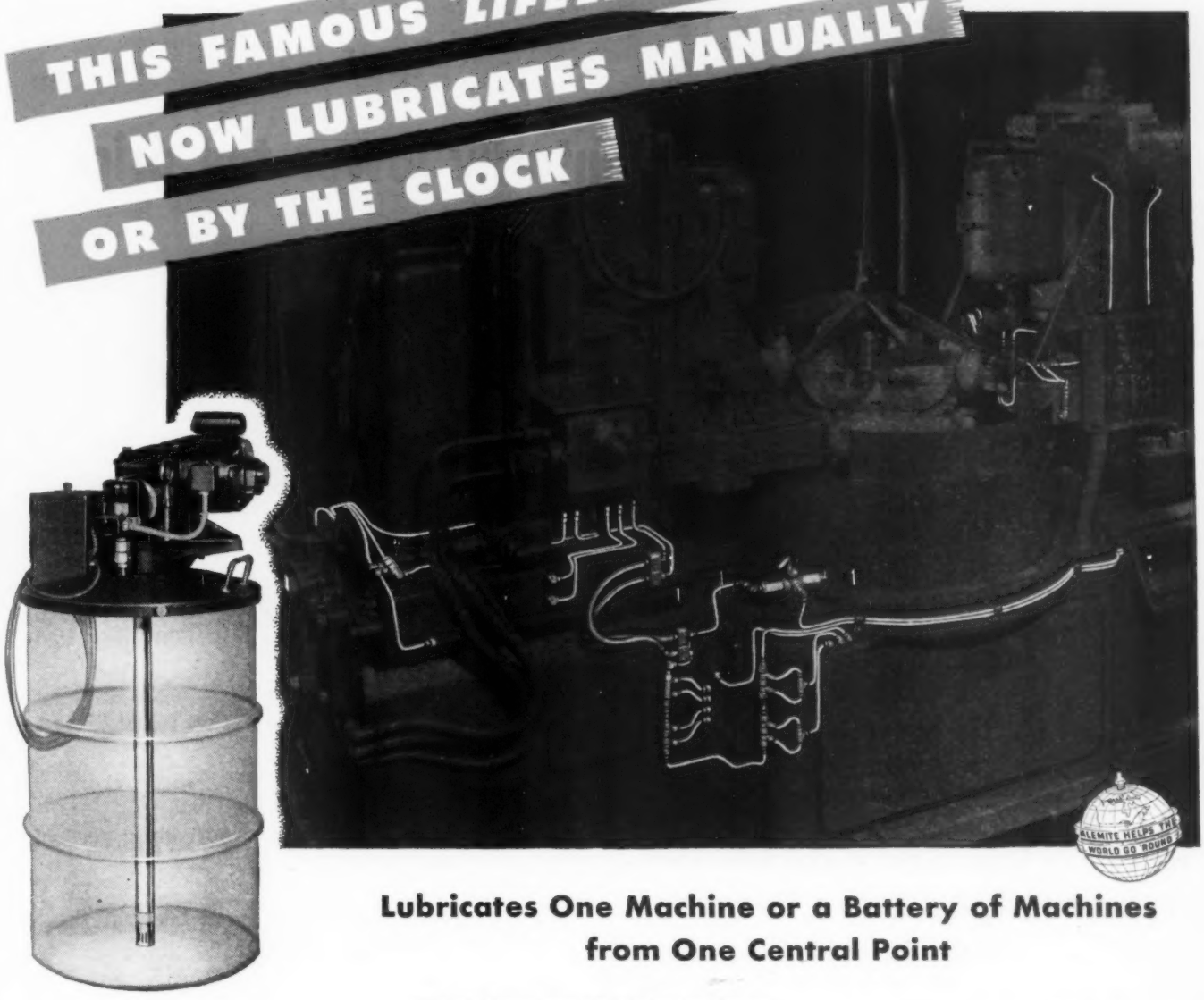
L-R Blowers produce maximum C.F.M. with minimum space and weight. Light-weight, high-impact plastic housings. Turbo-type wheels. Clockwise or counter-clockwise rotation.

L-R MANUFACTURING CO. Division of

The **RIPLEY** *Company*

TORRINGTON, CONNECTICUT

THIS FAMOUS "LIFELINE" NOW LUBRICATES MANUALLY OR BY THE CLOCK



Lubricates One Machine or a Battery of Machines from One Central Point

Naturally, you know how the Alemite Centralized Lubrication System eliminates the danger of human error. And how you can design any of the four types into almost any machine . . . to protect bearings and other vital parts, increase performance, lengthen machine life.

But did you know that this famous "lifeline" can now be used with a new series of ingenious Alemite Barrel Pumps which automatically feed oil or grease through the System's metal arteries *on the hour or on the minute?*

Each bearing, no matter how inaccessible, is given positive delivery of a measured quantity of lubricant at regular, predetermined intervals . . . *without stopping the machine.* A simple, built-in timing device controls frequency of lubrication for any interval from one minute to twenty-four hours. It can be easily adjusted or may be permanently set at the factory.

The human element is eliminated entirely except for replacing lubricant drums. And when drum is empty, a "howler" signal automatically gives both audible and visual warning. This signal may be installed in any desired location to warn either the machine operator on the spot or the factory superintendent in his office.

You owe it to yourself to investigate the many advantages of designing an Alemite Centralized Lubrication System into your machines . . . to discover how the famous "lifeline" that now lubricates manually or by the clock protects machines from costly human error.

Ask for a Demonstration Right at Your Desk

Without obligation, have an Alemite Lubrication Specialist demonstrate Centralized Lubrication with transparent working models. You can actually work them at your desk! He will gladly give you technical help regarding adaptation of Alemite Centralized Systems to your machines. Write Alemite, 1808 Diversey Parkway, Chicago 14, Illinois.

Another Product of STEWART WARNER

ALEMITE

REG. U.S. PAT. OFF.

First in Modern Lubrication

CONSULTATION • ENGINEERING • EQUIPMENT • LUBRICANTS • MAINTENANCE

★ ★ ★ ★ ★

What!... Voluntarily lower the price on a contract already awarded?

Don't be silly!

To lower the price on a contract involving a *new* part is one thing. But when you "bid in" at a lower price than anyone else on a contract covering a device that's already history—and still reduce the figure after the deal is closed—it's something altogether different.

Specifically . . . a contract to turn out a special aluminum part for a major company making automatic pilots for Uncle Sam's fighter planes.

We Cut Our Original Bid to Less Than Half.. And On Top of It Broke a Bottleneck

We bid low, at $38.10 per unit. Up until then, each part required 54 inches of intricate welding—and there had been a shortage of welders capable of doing it. Rejects at testing had been 40%. It had been possible to make only 500 a week.

To boost the output, we looked for a better way of doing it. The answer turned out to be "impact extrusion". Heretofore, manufacturers had used it only for small parts, limited to 2 inch diameter and 3 inch draw. In the process, we eliminated all but approximately 9 inches of welding—plus the need for critical aluminum tubing. Rejections dropped to about 2%. Production jumped to 500 a day, instead of 500 a week.

Our contract price $38.10—but we billed $18.85.

So, Uncle Sam gets the automatic pilots he needs . . . the prime contractor cuts his costs (on top of our original low bid)—and we're feeling very good about it.

Perhaps the fact that we have been in the subcontracting business for over 50 years has something to do with our ability to improve part designs, cut production corners and lower costs.

★ ★ ★

Write on your business stationery for 48-page book, "Let Lewyt Do It"—the story of the Lewyt organization in pictures. Lewyt Corporation, 60 Broadway, Brooklyn, N. Y.

ARMY E NAVY

Lewyt

A CONTRACT MANUFACTURER—EXPERTLY STAFFED TO PRODUCE COMPLETE ELECTRONIC AND MECHANICAL ASSEMBLIES, COMPONENT PARTS AND SUB-ASSEMBLIES, TO THE MOST EXACTING REQUIREMENTS

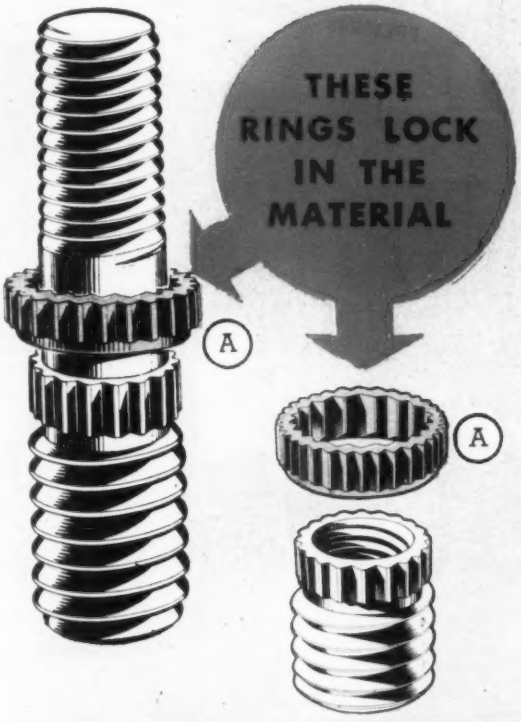
CONTINUE BUYING WAR BONDS

Locked-in FASTENINGS

For Metals, Plastics, Wood

THE ROSÁN LOCKING SYSTEM

Worker inspecting a Curtiss-Wright propeller power-unit which has Rosán Locked-in Threaded Inserts in the motor casing and reduction-gear housing, at their Clifton, New Jersey Plant.



THE ROSÁN LOCKING SYSTEM

DESIGNERS! Here is the answer to that problem of adequate fastening in soft metals, plastics, and wood. Rosán Threaded Inserts and Studs are locked in the material by the steel locking rings (A) shown in the illustrations at the left. Once installed, they are impervious to vibration or torque; yet they can be easily removed by a simple, shallow drilling operation . . . *and without disturbing the parent material.*

Torque may be applied to a nut frozen on the stud without loosening or backing it out. Castings with damaged threads may be easily repaired for salvage.

With these fastening units, it is now possible to use soft materials which have hitherto been considered impractical because a bolt or stud screwed directly into them would pull out under tension.

HOW THEY WORK

A locking ring (A), serrated inside and out, engages its *inner* teeth with a serrated collar on the Rosán Insert or Stud. The *outer* teeth of the locking ring broach their way into the parent material at the surface of a counterbore when driven or pressed into place. This makes the insert or stud an integral part of the parent material, and the installation completely permanent.

Send for this free catalog and submit your fastening problems to our Engineering Department. No obligation. When writing please give firm name and title, and address Dept. 8-75.

ARMY NAVY

A PRODUCT OF

BARDWELL & McALISTER, INC.

Box 1310 • Hollywood 28, California

EXCELLENCE OF THE PRODUCT REFLECTS EXCELLENCE OF THE PROCESS

MADISON-KIPP LUBRICATORS

Madison - Kipp Lubricators provide the most dependable method of lubrication ever developed. There are six popular models for every application. Illustrated is the Model OL, standard eight feed ratchet drive. Madison-Kipp specializes in lubricators for original Standard equipment. Write for special engineering data for your particular requirement.

Fresh Oil FED UNDER PRESSURE BY THE MEASURED DROP

MADISON-KIPP DIE CASTINGS

These castings are made by the Madison-Kipp Die Casting Process and are parts used in the assembly of the Madison - Kipp OL Lubricator above. The Madison-Kipp Die Casting Process offers the product designer almost unlimited opportunities to add pleasing appearance, light weight and improved strength at an over-all cost saving. Address all inquiries to our offices at Madison, Wisconsin.

MADISON-KIPP CORPORATION
206 WAUBESA STREET
Madison 4, Wis., U. S. A.

Sole Agent in England
Wm. Coulthard & Son
Ltd. Carlisle

Prelude to a —

perfect assembly

LORD
SHEAR TYPE
Bonded Rubber
MOUNTINGS

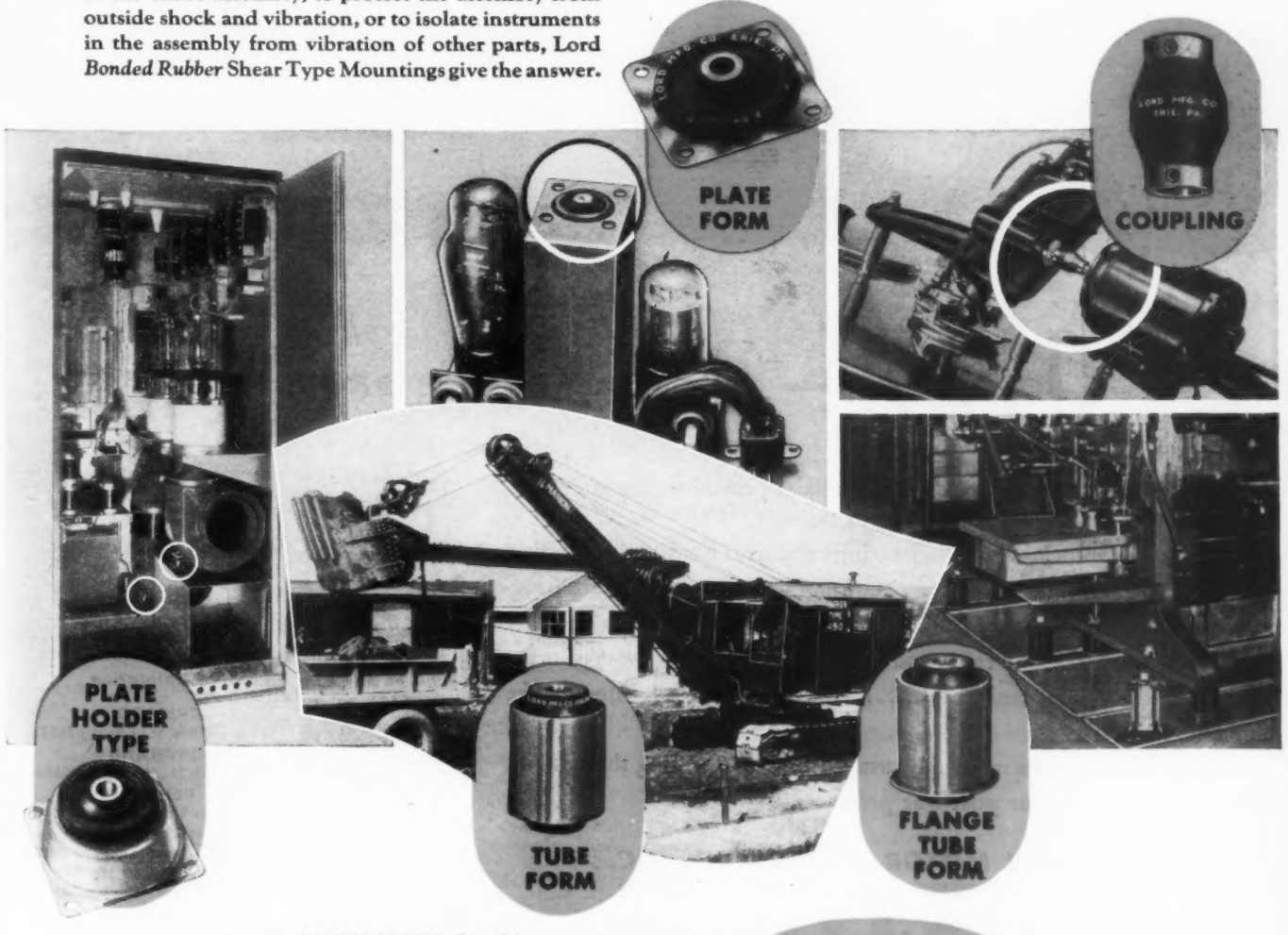
YOUR new product looks fine on the drawing table. Drawings don't suffer from vibration. But machines do. Their life is shortened, their production reduced in quantity and quality. And often the damage extends beyond the machine to other equipment, to your personnel, to the building itself.

Friction and vibration are the twin arch enemies of man-made machines. You have given a lot of thought to the bearings of your new product. Have you given equal attention to the mountings?

Whether you make gas-electric shovels or radios, huge printing presses, or delicate laboratory instruments; whether your problem is to control vibration of the entire assembly, to protect the assembly from outside shock and vibration, or to isolate instruments in the assembly from vibration of other parts, Lord *Bonded Rubber* Shear Type Mountings give the answer.

For almost a generation Lord has pioneered and led the way to constantly greater victories over the devastating effects of vibration. Let Lord engineers, with their specialized knowledge of vibration control, team up with your design engineers.

That team will give you a product of which you will be doubly proud; a product whose quiet efficiency will match its beauty, and whose enduring qualities will make enduring friends.



IT TAKES BONDED RUBBER *In Shear* TO ABSORB VIBRATION

LORD MANUFACTURING COMPANY
ERIE, PENNSYLVANIA

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CHICAGO - 520 N. MICHIGAN AVE.
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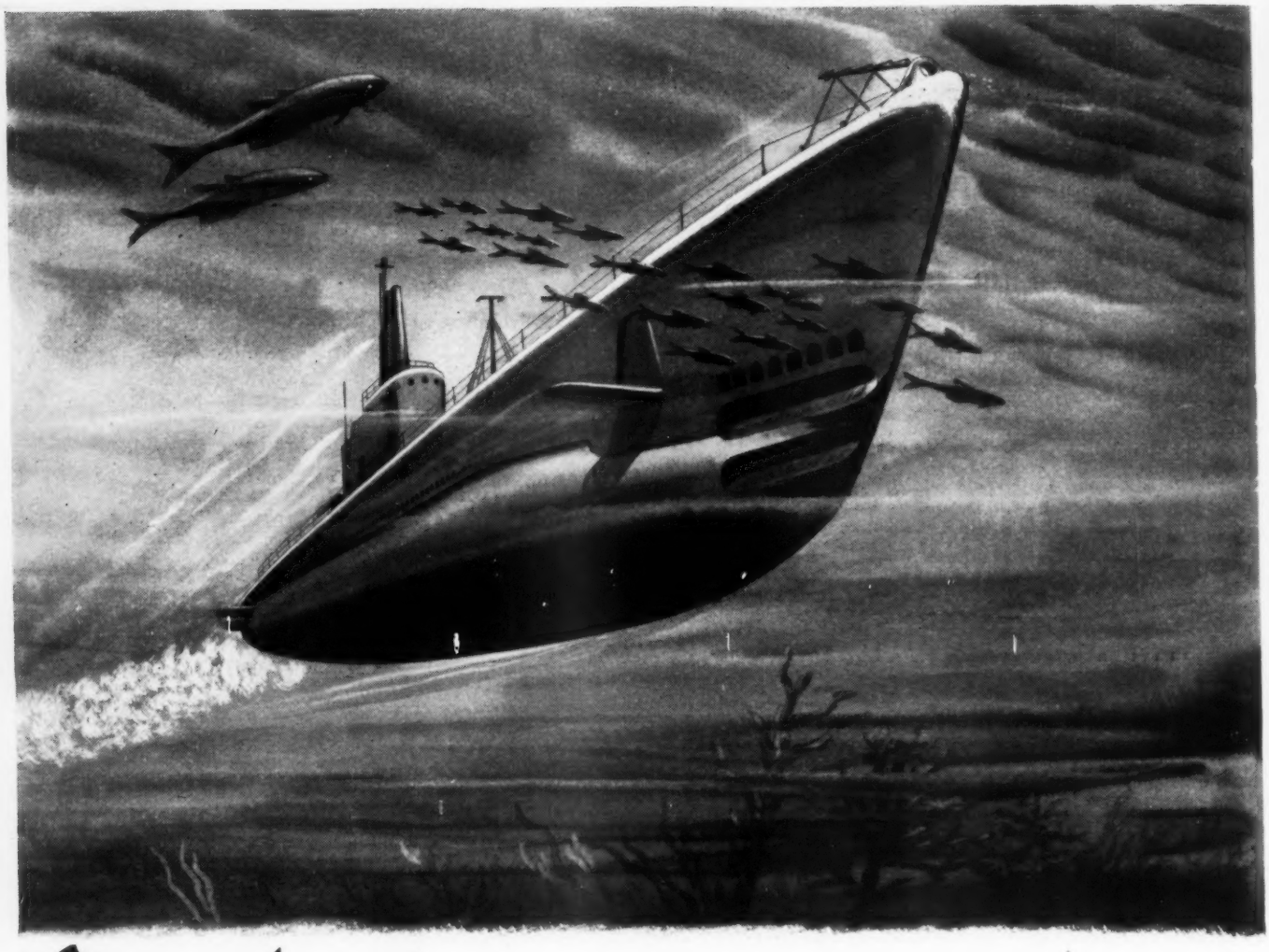
CANADIAN REPRESENTATIVES
RAILWAY & POWER ENGINEERING CORP., LTD.
TORONTO, CANADA

Originators of Shear Type Bonded Rubber Mountings



Sealed — SILENT, EFFICIENT PROTECTORS

Underwater, it's the submarine—in the modern machine, it's National Oil Seals that protect life . . . silently, efficiently.

By retaining the lubricant in bearings and gear housings...keeping out abrasive, extraneous matter, National Oil Seals are adding long-life and trouble-free performance to machines of all kinds in many diversified fields. Their value and efficiency have been proved in the most gruelling mechanical tests... the modern automobile and the machines of war.

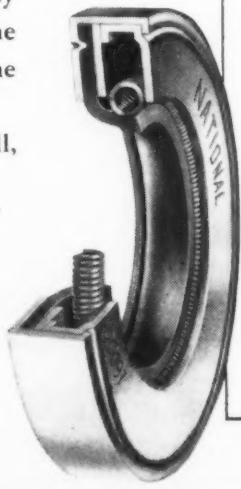
Investigate now the many advantages of incorporating these small, compact units in your post-war products.

1050

NATIONAL MOTOR BEARING CO., INC.

General Offices: Redwood City, Calif. • Plants: Redwood City, Calif., Van Wert, Ohio • Los Angeles, Calif. (Arrowhead Rubber Company)

NATIONAL
OIL AND FLUID SEALS



CALL IN A NATIONAL ENGINEER FOR RECOMMENDATIONS
No Obligation

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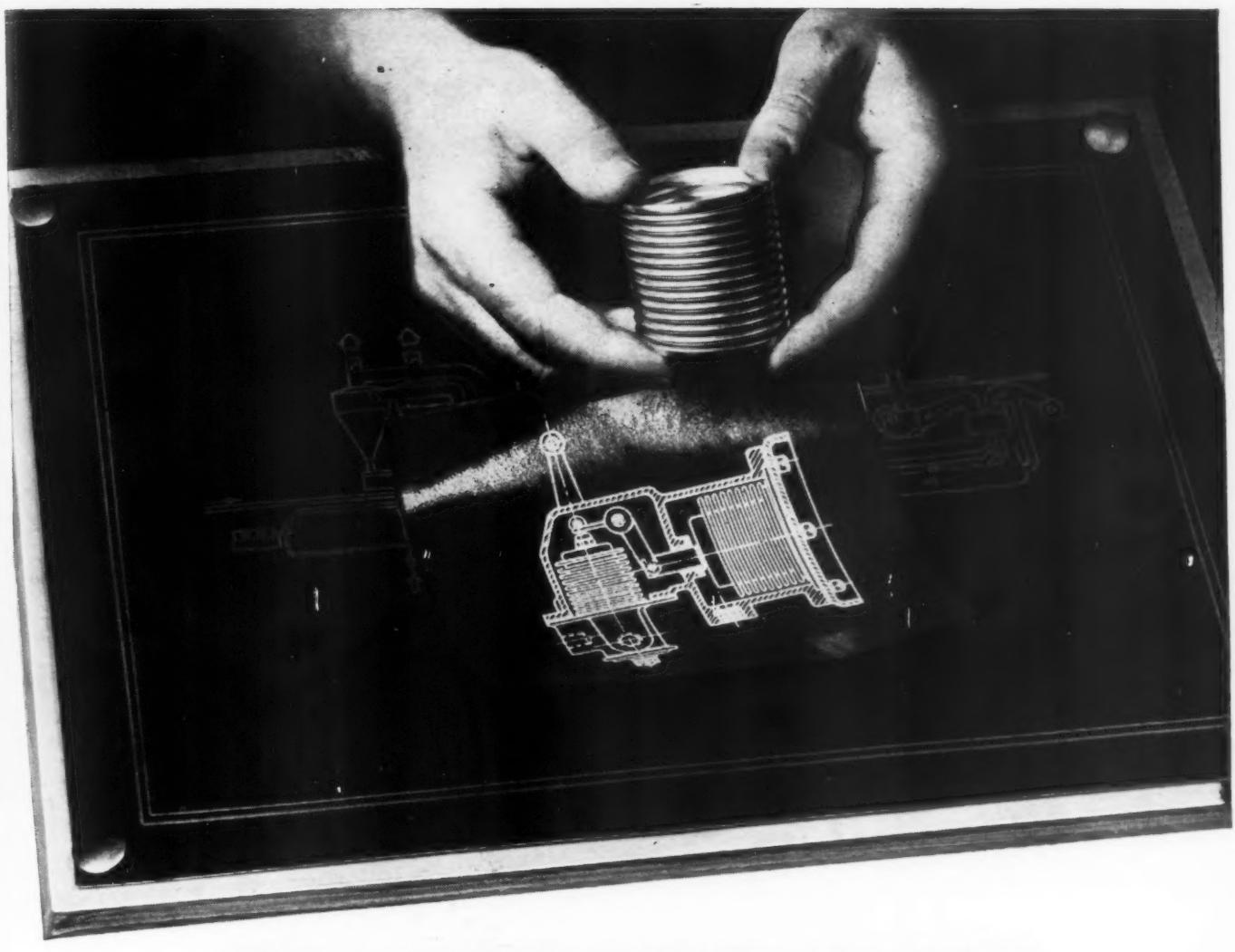
WHEREVER SHAFTS MOVE, THERE'S A NATIONAL OIL SEAL TO RETAIN THE LUBRICANT

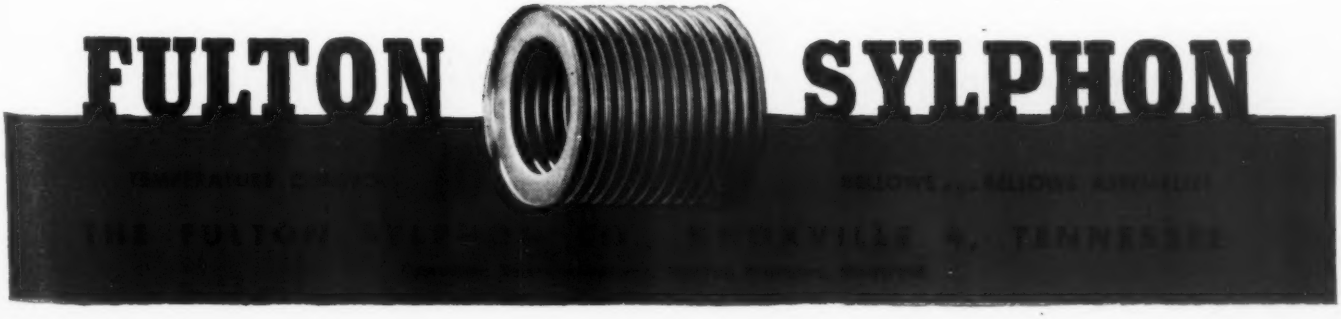


FITS INTO YOUR PLANS

CHECK YOUR PLANS—study your instrument drawings. If you're in any one of a great number of industries, you're either using bellows or you'll probably find a place where the Sylphon Bellows will do a particular job better.

When fitted with proper heads and charged with a thermo-sensitive liquid, the bellows becomes a thermostat—a powerful little "motor" deriving its power from changes in temperature of the confined liquid. Without the liquid charge, the assembly could be used as a pressure "motor." In either case the developed power could be employed to "make" and "break" electrical circuits, open and close valves, dampers, etc. Bellows have other applications, such as for expansion chambers, flexible joints, packless construction, seals, etc.—in fact their uses are virtually without limit.

Sylphon Bellows are ready to fit into your post-war plans—simplify and improve existing designs—be the key perhaps, to revolutionary new developments. For the complete story write for Bulletin No. NT-1300.



HYCON

REGISTERED TRADE MARK

The wide field of use is illustrated by the list of applications shown below where these compact units have displaced manual and mechanical equipment.

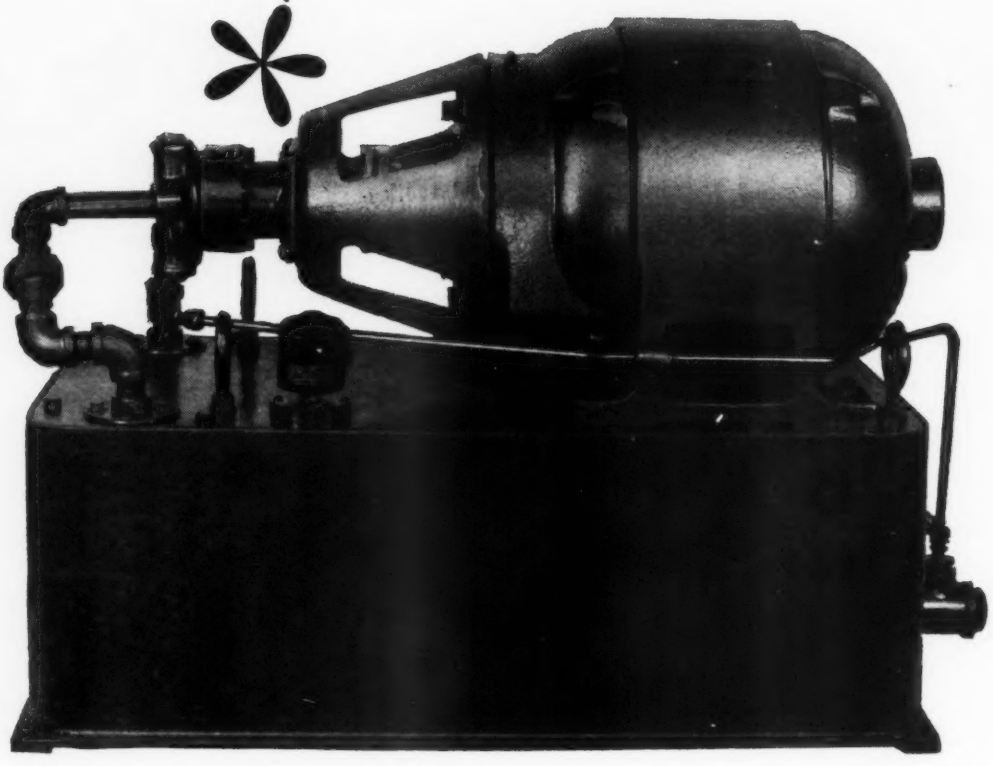
TEXTILE FINISHING ROLLS • STEEL ROLL MILLS BRASS ROLL MILLS • SCALE BREAKER ROLLS STARTING TORQUE RELIEF • DIE CLAMPS PRODUCTION PRESSES • LABORATORY PRESSES • HYDROSTATIC TESTS • AUTO-CLAVE PRESSURE SEALS • BEARING FLOTATION • HIGH PRESSURE CLOSING AND DWELL

Automatic

Hydraulic Pressure

•

1.2 GPM	3000 p.s.i. Continuous	33″ x 15″ x 13″ High
2.4 GPM	3000 p.s.i. Continuous	33″ x 16″ x 24″ High



To provide for a wider range of automatic control, the basic units can be furnished with accessory equipment including accumulators, pressure switches, pressure metering valves, manual or solenoid operating valves.

For operations requiring large prefill capacities, comparable units are built with two-pump combinations to provide high volume, low pressure, and high pressure closing and dwell cycles.

Write today for detailed information

EXPERIENCED HYDRAULIC ENGINEERING SERVICE IS AVAILABLE

•

THE NEW YORK AIR BRAKE COMPANY

Hydraulic Division

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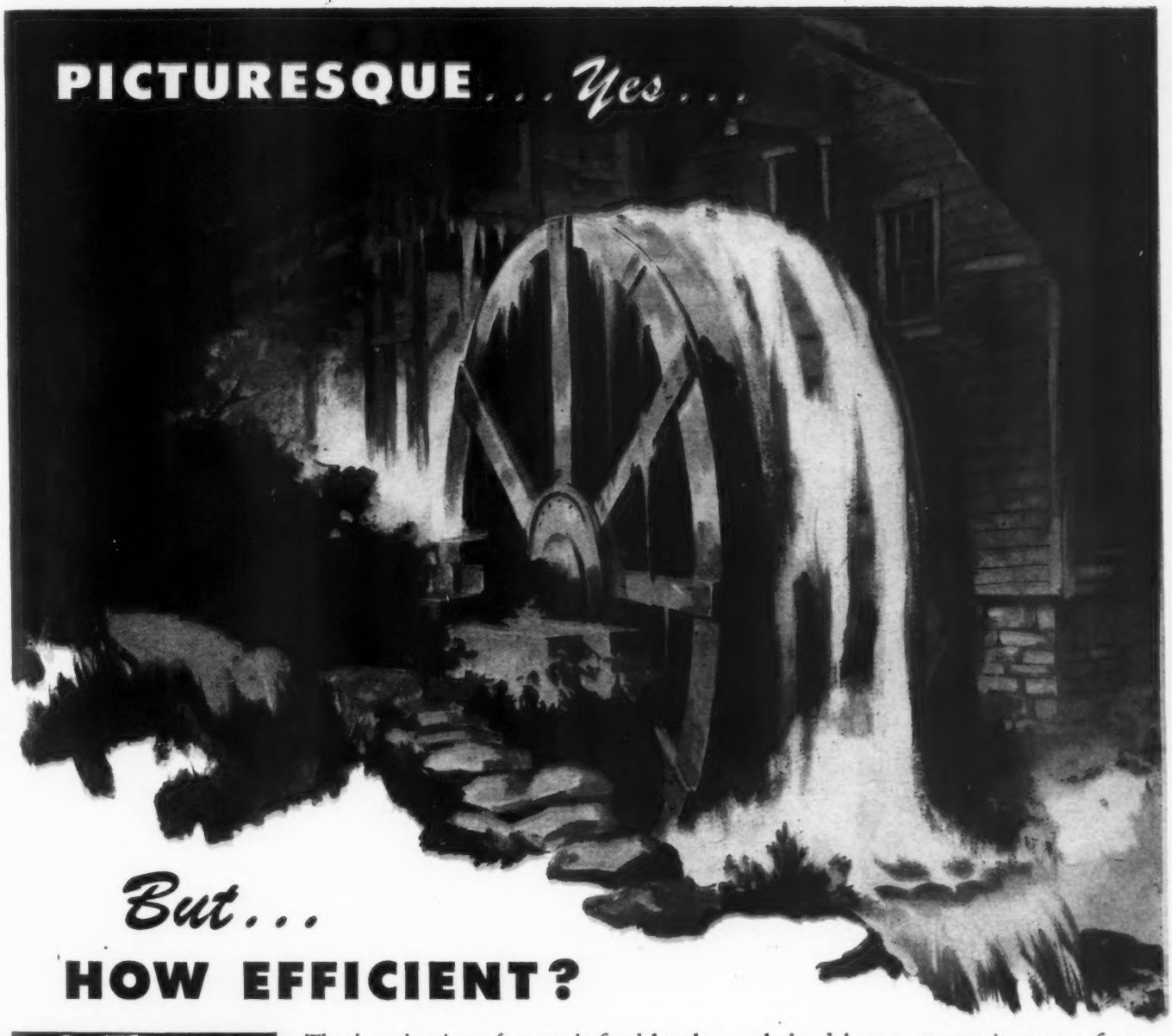
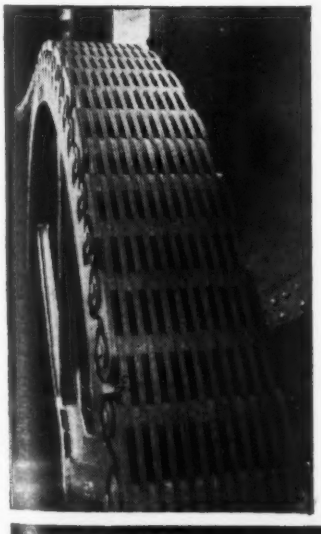


But . . .

HOW EFFICIENT?



The imagination of poets is fired by the romance of a water wheel. Inside the quaint, old mill, a maze of shafts, belts, cogs and pulleys, suspended from huge, cobwebbed beams, forms an interesting and complex, though not efficient, pattern of power transmission. As industrial progress replaced the water wheel with the turbine and other mechanical improvements which demanded even better means of power transmission, Morse began to perfect chain drives.

Morse research has developed positive chain drives to transmit power from a fraction of a horsepower in an intricate and delicate scientific instrument up to 5000 horsepower in a single drive.

Today, this background of experience in power transmission efficiency is speeding war production and driving our implements of war to Victory. Tomorrow this skill and precision will be turned to faster and better production for peace. Ask your Morse engineer how *you* can increase production with better drives.

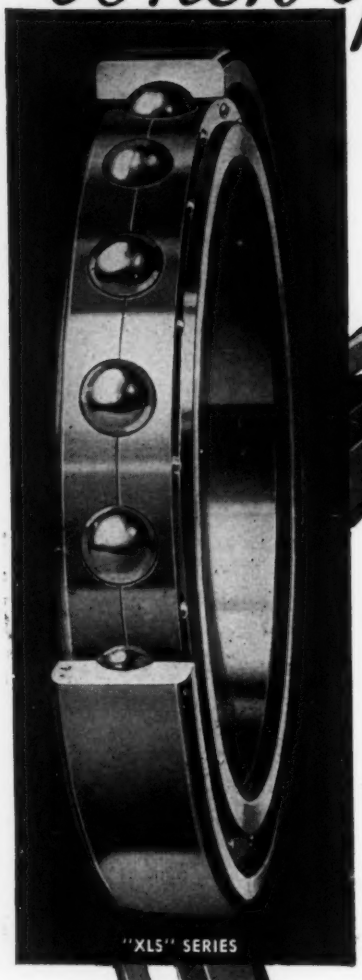
SPROCKETS CHAINS FLEXIBLE COUPLINGS CLUTCHES

MORSE *Roller and Silent* **CHAINS**

MORSE CHAIN COMPANY • ITHACA, N.Y. • DETROIT 8, MICH. • A BORG-WARNER INDUSTRY

When You're Cramped for Space

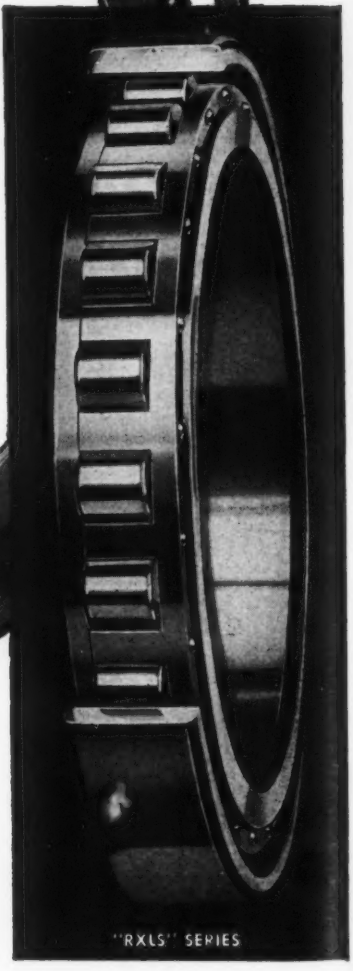
USE THESE VERY LIGHT INCH SERIES BEARINGS



HAVING bores abnormally large, as compared with the outside diameter, they offer definite advantages under certain conditions found in machine design. You may have them in several different types, *affording compactness, light weight, and greater latitude in your design.*

There are several lines of very light type ball bearings, which include the "S" starting at 1/8" bore, and the "XLS" starting at 1 3/8" bore, running up to a maximum of 21" bore and 28" outside diameter. And in very light type roller bearings, there is the "RXLS" Series, paralleling the "XLS" in size range.

Why not let our engineers tell you more about these Very Light Precision Bearings? Write for the Catalog.



"NORMA-HOFFMANN"

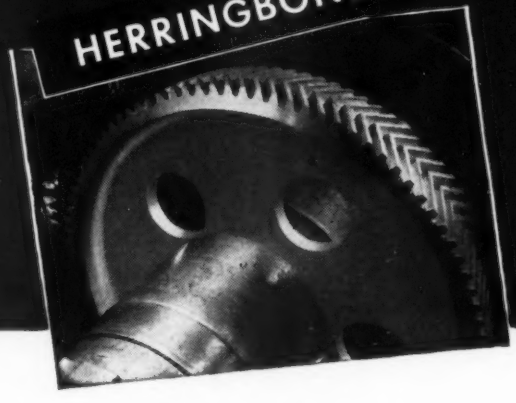
PRECISION BALL, ROLLER AND THRUST BEARINGS

NORMA-HOFFMANN BEARINGS CORP'N. STAMFORD, CONN., U. S. A.

GEARS

ALL TYPES

ALL SIZES



From Philadelphia, you can get practically any type or size of industrial gear that can be made. In addition you can get the benefit of the experience we've gained through specialization for over a half century. This knowledge, with our vast, modern gear manufacturing facilities can be applied advantageously to meet any particular gear problem you may have . . . chances are we have already encountered a similar problem and licked it.

Remember, large or small, we make them all . . . to a fine degree of accuracy.

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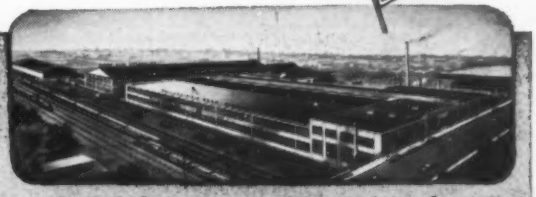


Industrial Gears and Speed Reducers

LimiTorque Valve Controls

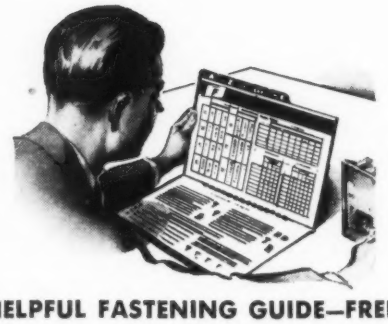
Will your Post-war Product Plans take this hurdle in stride?

HAVE YOU given assembly its proper attention in planning your post-war product – or will your time sheets tell you, after you are all set up, that fastening "bugs" are eating up savings you could have been making?

NOW, BEFORE YOU START production, question every fastening. Find out where you can use the short cut method – with P-K Self-tapping Screws – before you put up with slower, more complicated methods.

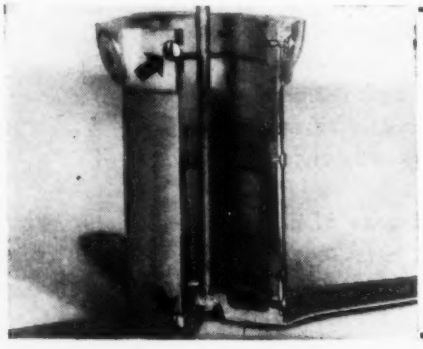
IN 7 OUT OF 10 CASES experience proves that with P-K Screws you can save time – speed assembly – cut costs – reduce rejects – improve products – by eliminating needless tapping, awkward bolting, costly inserts in plastics that slow up molding.

ASK A P-K ASSEMBLY ENGINEER to help you find all the savings you can make – often from 30% to 50% – or, send assembly details for recommendations.



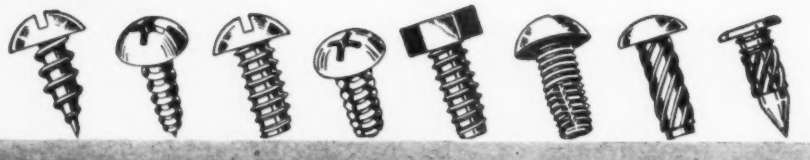
HELPFUL FASTENING GUIDE—FREE!

The 18 tab-indexed pages are crammed full of information on where and how to use P-K Self-tapping Screws, in metals or plastics. File size, fitted with wall-hanger. Write for it. Parker-Kalon Corp., 208 Varick St., New York 14, N. Y.



FASTER ASSEMBLY OF AIRCRAFT SEATS NO SACRIFICE OF STRENGTH

"P-K Type 'F' Screws enabled us to make two important assembly short cuts . . . we eliminated tapping, and solved troublesome riveting problems," says Warren McArthur Corp., New York. "P-K Screws give us the rigid unshakable fastening we must have, without the use of lock washers." Sectional view shows some of fastenings to aluminum.



PARKER-KALON
Quality-Controlled
SELF-TAPPING SCREWS

FOR EVERY METAL AND PLASTIC ASSEMBLY

RBC ENGINEERS COOPERATE

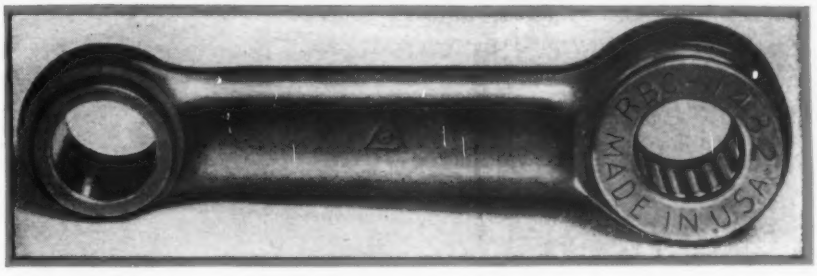
Unique In The History Of Bearing Design!

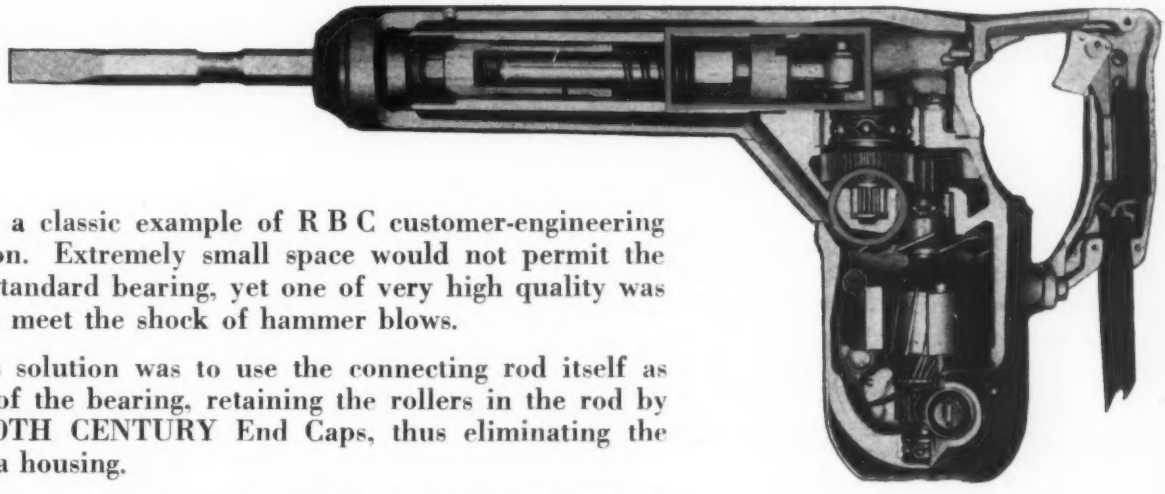
IN SOLVING A PROBLEM FOR Black & Decker

RBC 20th CENTURY BEARINGS

were the answer

Rollers fit inside the connecting rod, and are held in place by end covers.





Here is a classic example of R B C customer-engineering cooperation. Extremely small space would not permit the use of a standard bearing, yet one of very high quality was needed to meet the shock of hammer blows.

R B C's solution was to use the connecting rod itself as the race of the bearing, retaining the rollers in the rod by use of 20TH CENTURY End Caps, thus eliminating the need for a housing.

To the right is shown the complete 20TH CENTURY BEARING as installed in another part of the electric hammer. Because of high load carrying capacity and small outside diameter, these bearings are the real answer for such applications. Plan NOW to make use of them in your post-war designs.

RBC MORE THAN 25 YEARS EXPERIENCE

SOLVE THAT SPACE AND WEIGHT PROBLEM
BY CONSULTING RBC ENGINEERS

Send For Catalog

ROLLER BEARING CO. OF AMERICA
TRENTON, NEW JERSEY

DESIGNS, TOOLING AND PRODUCTION ECONOMIES

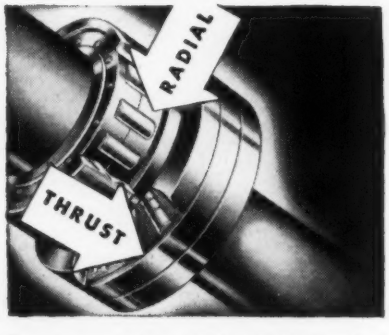
Ready-made for

THRUST APPLICATIONS

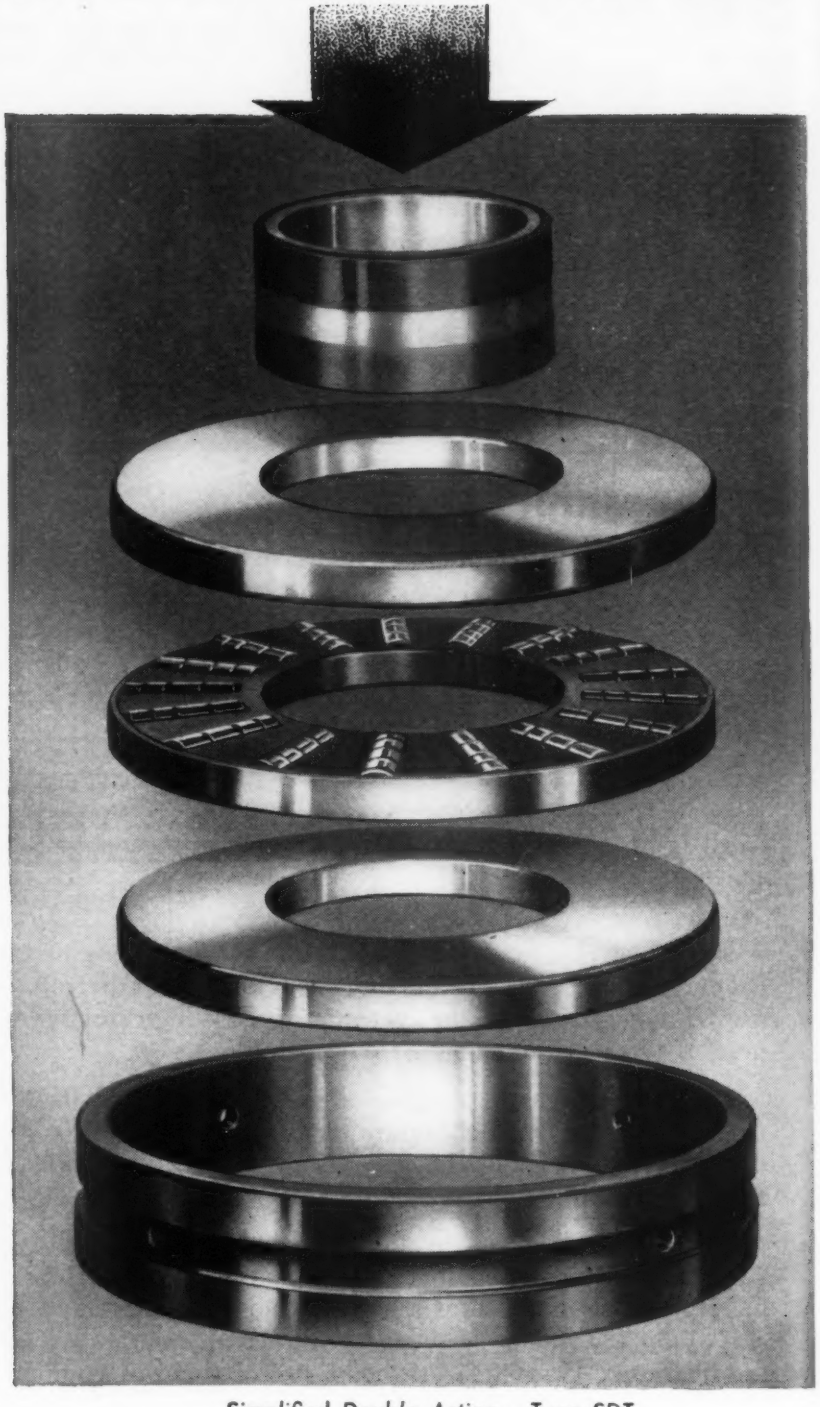
Rollway roller thrust bearings offer the widest selection in types and sizes. All the preliminary designs, tooling and production methods have been set up—assuring low cost and quick delivery for most applications.

Thrust loads are carried at right angles to the axes of solid cylindrical rollers. Rollers that are shortened to provide true rolling, and staggered to equalize distribution of wear. There are no diagonal resultants, no piling up of radial and thrust loads on the same bearing assembly. That's why you can carry heavier continuous, intermittent or reversing loads over longer periods of life expectancy—even under severe shock or vibration. Where compound loads are encountered, separate radial bearings carry the radial component, also at right angles to the roller axes.

ROLLWAY BEARING COMPANY, INC.
Syracuse, N. Y.



For compound loads SEPARATE radial and thrust bearings are used in combination as per diagram.



Simplified Double Acting — Type SDT

Select Bearings for the Job They Do

Size of shaft, limiting features of the application, loads, speeds and the duties required of the machine, all have an influence on the type and size of bearing you should use. Our engineering specialists will gladly make necessary calculations, drawings and supply the information required for a complete understanding of the problem. No charge or obligation.

ROLLWAY CYLINDRICAL ROLLER BEARINGS

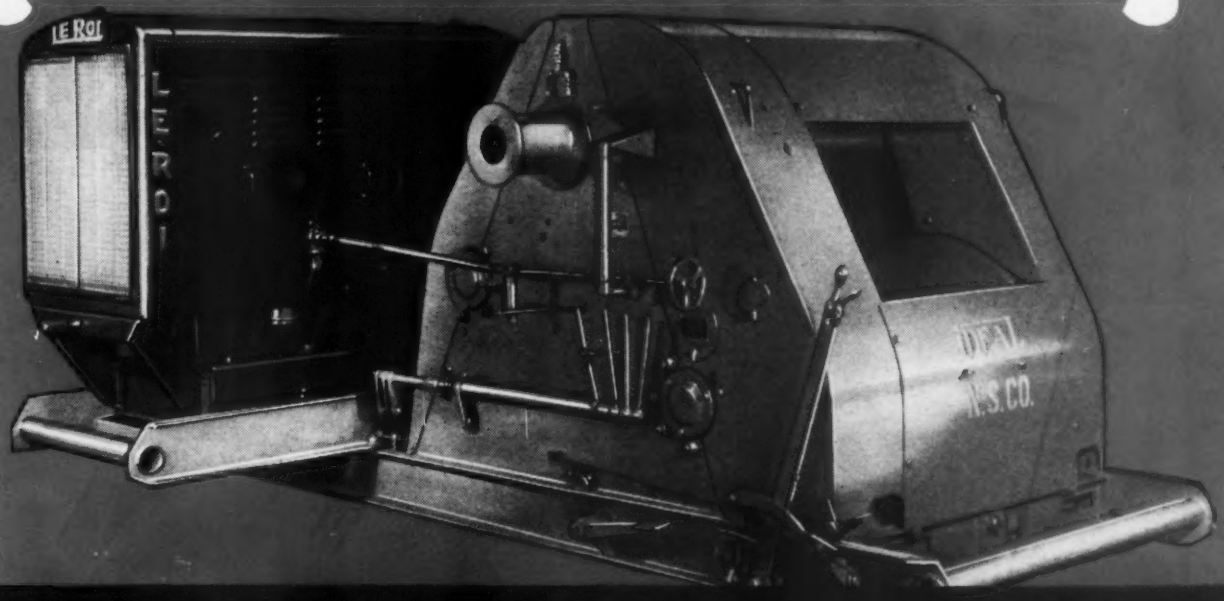
SALES OFFICES: Philadelphia • Boston • Pittsburgh • Youngstown • Cleveland • Detroit • Chicago • St. Paul • Houston • Tulsa • Los Angeles

Case History No. 40

The National Supply Co. relies on this husky Le Roi Model RXIS ENGINE to power their Ideal Consolidated Drilling Rig.

Features of Model RXIS Le Roi Engine

A 6-cylinder model that develops 170 H.P. at 900 R.P.M. Features include drop forged crankshaft; alloy steel camshaft; steel-backed babbitt-lined precision bearings; water-cooled exhaust manifold; valve-in-head construction; large gear type oil pump; replaceable valve-guide sleeves; heat-treated, alloy steel valves; plus many others.



For PERFORMANCE that is dependable . . . for ECONOMY that keeps costs down . . .

power your equipment with LE ROI ENGINES

LE ROI
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Standard equipment on leading makes of:

OIL FIELD EQUIPMENT
Drilling rigs • Well pumps • Pipe-line service • Receiving and main-line pumps • Generators.

CONSTRUCTION MACHINERY
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For more than a quarter-century, Le Roi Engines have proved their ability to perform dependably and economically on one tough job after another. In every theater of war Le Roi Compressors — Le Roi-powered — are doing an outstanding job to demonstrate the truth of this statement.

One of the fundamental reasons for this ability to perform dependably is the fact that Le Roi Engines come from a source that concentrates exclusively on the problems of the heavy-duty field. They have the weight and stamina to take the punishment handed out to field equipment — without costly breakdowns.

Le Roi engineers are prepared to adapt components and accessories to your own specialized power requirements and are happy to cooprate with your staff. Write for further information. No obligation.

D-4

Le Roi Company
1708 S. 68th STREET • MILWAUKEE 14, WISCONSIN
Heavy-duty internal combustion engines from 4 to 400 H.P. — using gasoline, natural gas, or butane.

3 Standard Fastenings for Production Efficiency

1 Phillips Recessed Head Screws—The modern, effective, time-saving fastening device proven in tens of thousands of assembly lines. Other standard head styles are also available.

2 Self-Tapping Machine Screws—Eliminate separate tapping operations for fastenings to castings, heavy gauge sheet metal, and plastics. Also available with Phillips Recessed Head.

3 Washer-Screw Assemblies—When use of lock washers is indicated, the time-saving of pre-assemblies is obvious. Also available in standard slotted head styles.

"Cold-forging"—proof #33 . . . more each month

The degree of perfection you will obtain on that vital fast assembly job may very well depend on the fastenings chosen for your product. That's why it is important to play safe by making your precise choice early in the design stage. Remember—no assembled product can be better than its fastenings.

Whether your need be a featured standard fastening or a part especially designed to meet your specific requirements—Scovill can help you. Our broad experience in fastenings and our demonstrated ability in special design make Scovill your logical choice.

The special purpose item featured above (in intermediate and finished stages) is one of many examples of our ingenuity in special design and cold-forging. Our special processing of this part, too, meant substantial savings in money—materials—motions.

Call our Fastenings Expert to help you choose—profit by Scovill skill in design and cold-forging. Call *today*.

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WATERVILLE SCREW PRODUCTS DIVISION

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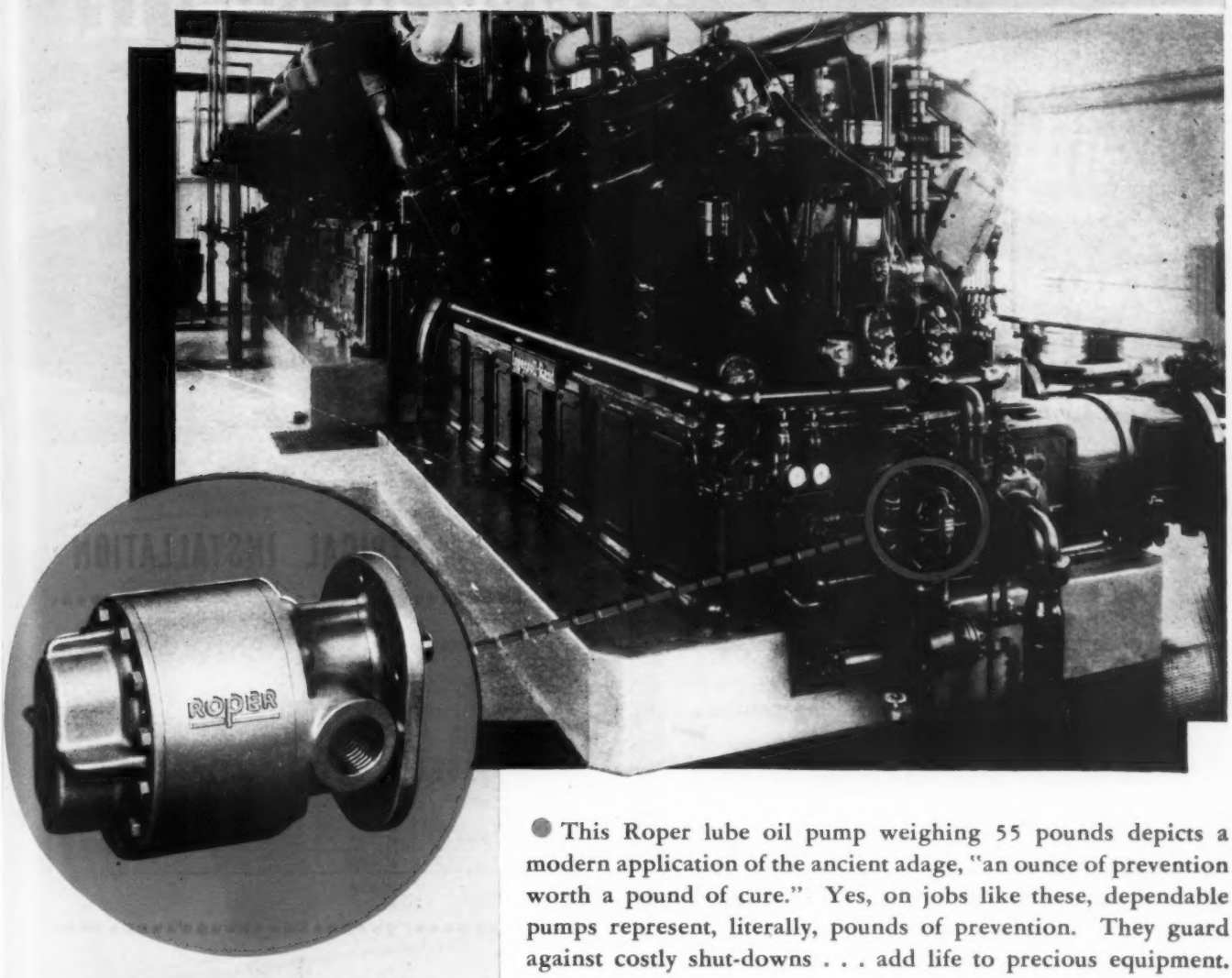
55 POUNDS of PREVENTION

ROPER ENGINEERED LUBE OIL PUMP SAFEGUARDS INGERSOLL-RAND COMPRESSOR



JOB FACTS

(Above) Roper flange-mounted unit connects directly to crankshaft. Pumps SAE 30 oil. Temperature range 130° F to 150° F. Pump speed 175 to 350 r.p.m. Operating pressure 45 lbs. p.s.i. Capacity range 12 to 28 g.p.m. Like other Roper pumps, it's engineered for a specific job. Assembled from standard precision-machined parts, it's built and especially engineered for long dependable service.

FREE ENGINEERING SERVICE

A staff of competent experienced Roper engineers are ready and willing to help you solve your pumping problems. There is no obligation. Simply send us details of your problems, or get in touch with Roper field engineers located in principal cities. Ask for free Catalog, also Booklet, "How to Solve Pumping Problems".

● This Roper lube oil pump weighing 55 pounds depicts a modern application of the ancient adage, "an ounce of prevention worth a pound of cure." Yes, on jobs like these, dependable pumps represent, literally, pounds of prevention. They guard against costly shut-downs . . . add life to precious equipment.

To make sure of dependable performance, Roper engineers apply the prevention principle, also, in building pumps. *For example,* oversize journal bearings are employed to support gears at both ends. Identical size external gears, accurately machined, equalize wear and prolong life.

In addition, each pump is engineered for the specific job . . . is tailored to fit individualized requirements. *Write today for details on Roper service.*

WRITE FOR CATALOG No. 7-47

GEO. D. ROPER CORPORATION
ROCKFORD, ILLINOIS

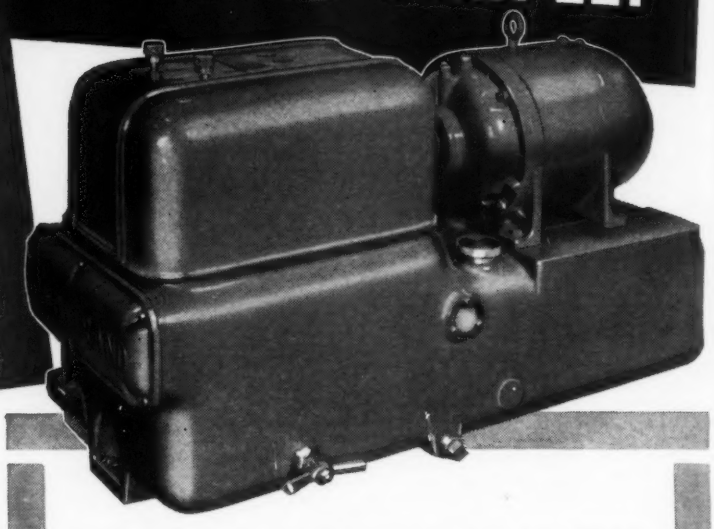
PUMPS ESPECIALLY ENGINEERED TO FIT YOUR REQUIREMENTS

ROPER *Rotary Pumps*

BUILDERS OF PUMPS FOR MANUFACTURING, MARINE, PETROLEUM, AND PROCESS INDUSTRIES

APPLYING HYDRAULICS IS SIMPLE!

with a Sundstrand CIRCUIT-UNIT



Here's a simple solution to your hydraulic machine design problems. A Sundstrand circuit-unit, complete with valves, pumps and tank, provides a compact hydraulic power unit easy to install and service. With electrical control, the only piping required when assembling unit to your machine are two pipes leading to each cylinder or other motivating members.

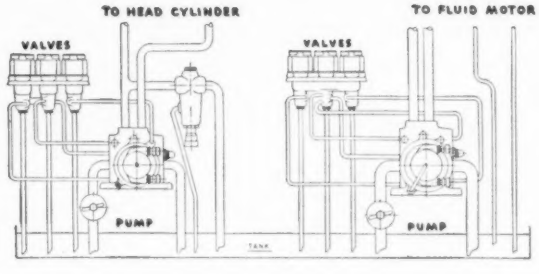
NO HYDRAULIC ENGINEERING DEPARTMENT NEEDED

● A complete hydraulic circuit is designed for your machine while you are designing the machine. There is no need for a separate hydraulic engineering department in your plant. Further, the circuit will be built from *standard* Sundstrand valves, pumps, etc. . . . placing the entire responsibility in the hands of one supplier.

SAVES DESIGN AND ASSEMBLY TIME IN YOUR PLANT

● When your machine is ready for final assembly and testing, your pre-tested Sundstrand circuit-unit will be ready for mounting to the machine. Attaching the unit, connecting the pipes, and wiring completes the job.

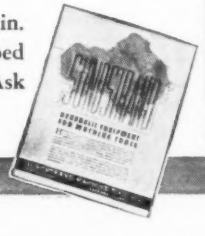
HERE'S A TYPICAL INSTALLATION



The circuit shown was designed into a Sundstrand circuit-unit for actuating a profile milling machine. The cutter head is held in steady pressure contact by a head cylinder. The work table is rotated by a Sundstrand Oil Power Fluid Motor. Automatic cycle is controlled by dog-operated switches governing solenoid valves in the circuit-unit.

FREE ADDITIONAL DATA

is contained in this eight page bulletin. Three types of circuit-units are described in detail. Write for your copy today. Ask for bulletin PWX-B.



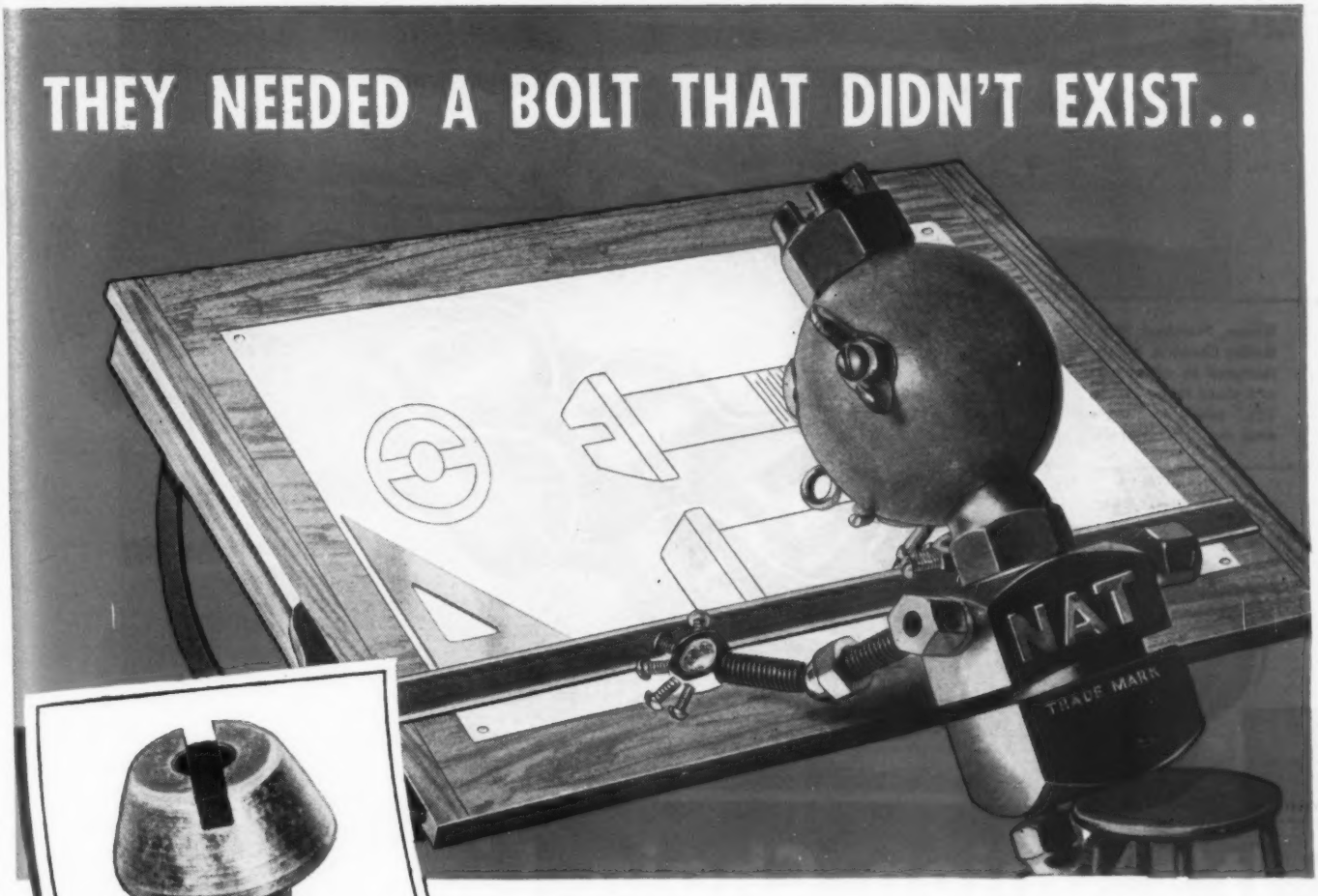
SUNDSTRAND MACHINE TOOL CO. · ROCKFORD, ILLINOIS, U.S.A. ·

SUNDSTRAND PUMP DIVISION

2560 ELEVENTH STREET • ROCKFORD, ILLINOIS

FUEL UNITS • HYDRAULIC PUMPS • TRANSMISSIONS • FLUID MOTORS • VALVES and CONTROLS

THEY NEEDED A BOLT THAT DIDN'T EXIST..



So we designed a Special Bolt..

The right fastener for the job!

Here's another typical example of National's Technical Service—a special fastener designed for the particular application when standard fasteners don't meet the need:

In a certain rubber molding operation a bolt was required that could be pulled up tight and used for many applications. Extra large bearing surface was needed, as well as exceptional strength and high "torquing" capacity.

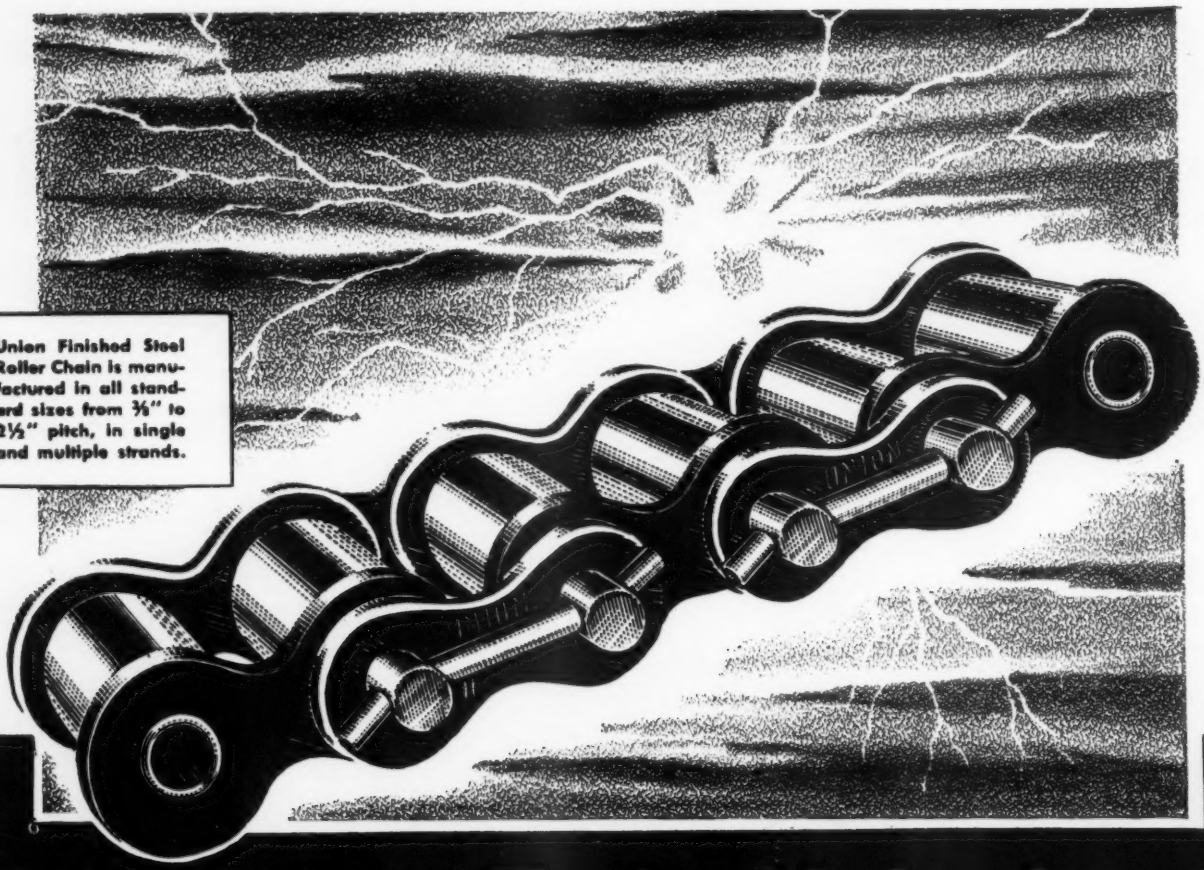
We designed the bolt of alloy steel, with a specially formed slot which permits use of a reinforced driver. This prevents slipping or shearing of the driver point. The large diameter at the base of the head affords ample bearing surface, while the tapered sides reduce the amount of metal in the head, making it possible to upset the bolt, an important cost factor.

You may need just such a service as this to improve your fastenings. Often we can save production time and cost by upsetting a part instead of milling from bar. Let us have your inquiry.

Send for a copy of this case history booklet describing briefly, with diagrams, typical instances of National's Technical Service. Ask for the "Savings" booklet.

National
HEADED AND THREADED
PRODUCTS

THE NATIONAL SCREW & MFG. CO., CLEVELAND 4, O.



Union Finished Steel Roller Chain is manufactured in all standard sizes from ⅜" to 2½" pitch, in single and multiple strands.

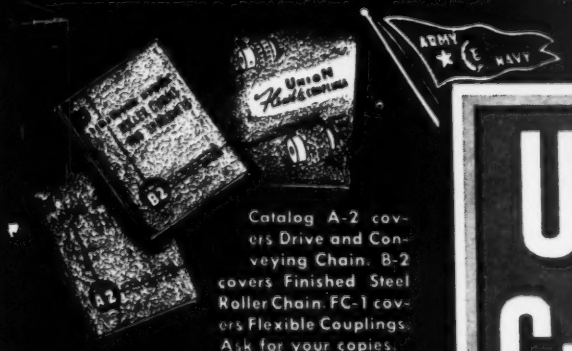
It's Union Chain Lightning !

☆ Maybe this is stretching a figure of speech to the breaking point, but some first-time customers tell us that we have been able to banish their chain problems just as a severe electrical storm clears the heavy ominous atmosphere on a hot summer's night.

And if we have, it is doubtlessly because Union specializes on chain, confining ourselves to the manufacture of a complete line of steel chains, sprockets and flexible couplings. We are interested in each application of our chain and check to be sure it is properly installed and correctly lubricated. No wonder Union Chains often last longer than their buyers expect.

Ours is one kind of Chain Lightning you need not fear. Call in Union on your next chain requirement and watch for Union Chain Lightning to strike.

The Union Chain and Manufacturing Company ..... Sandusky, Ohio, U. S. A.



Catalog A-2 covers Drive and Conveying Chain. B-2 covers Finished Steel Roller Chain. FC-1 covers Flexible Couplings. Ask for your copies.

Union Chains for Every Application

Drive and Conveying Chains and Sprockets
- Bridge Chain
- Combination Malleable Iron and Steel Chain
- HB (hardened bearing) type chain
- BP (bar and pin) type chain

★

Finished Steel Roller Chains and Sprockets
- All manufacturer's standard, size ⅜ in. to 2½ in. pitch
- Single and Multiple Strands
- Extended Pitch Series in sizes 1¼ in. to 4 in. pitch

★

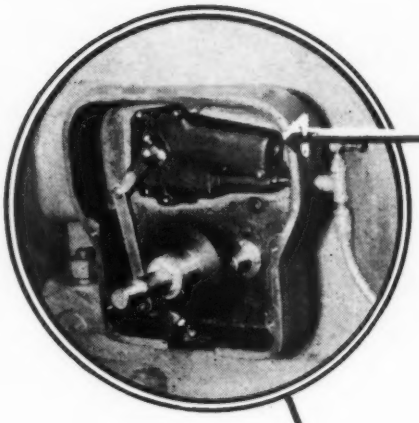
Silent Chain and Sprockets
- All sizes ⅜ in. to 1½ in. pitch

★

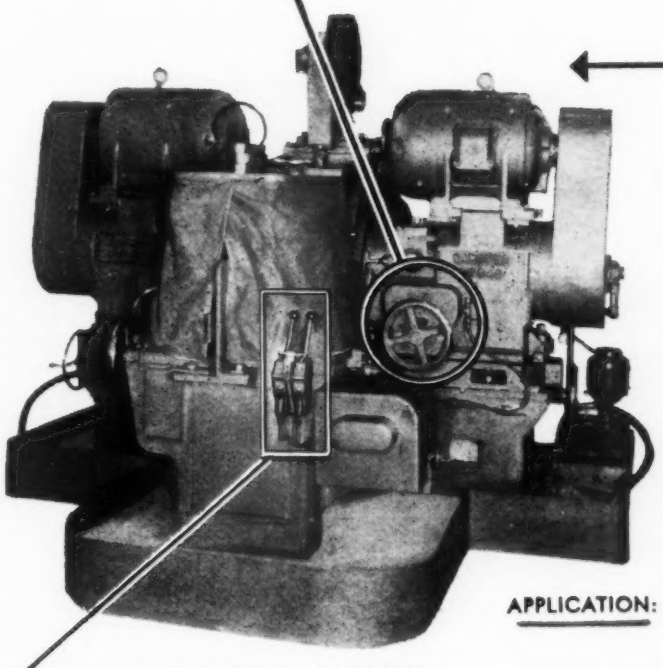
Flexible Couplings
- Roller chain type
- Silent chain type

UNION CHAINS

SPERRY HYDRAULIC REMOTE CONTROLS for the MACHINE TOOL INDUSTRY



SPERRY'S HYDRAULIC CONTROLS **minimize design problems by means of a single connecting tube that can be bent around corners and obstacles, or installed through walls, thus reducing design, installation, and maintenance costs.**



The machine shown at the left is a No. 84B-30" GARDNER DOUBLE SPINDLE PRECISION GRINDER, manufactured by Gardner Machine Company, Beloit, Wisconsin. On top the canvas spray protection hood are several bearing races ground by this machine; turned out at high rates of production and to extremely close tolerances. 4" diameter races are ground at a rate of 40 per minute, holding ground surfaces to .0003" to .0005" of parallelism.

TRANSMITTERS ARE EASILY LOCATED IN MOST ADVANTAGEOUS POSITION

APPLICATION: Remote Control of operating feed on Gardner Double Spindle-Precision Grinder.

PROBLEM: Original specifications called for Solenoid operated feeds. Initial installation presented the following difficulties:

a. Feed operated with too much shock on feeding mechanism.
b. Could not be relied upon to hold such necessary close infeeds as .0001".

EASY INSTALLATION
DEPENDABLE
ACCURATE

●

SOLUTION: The Gardner Company changed to Sperry Hydraulic Controls with the following results:

a. Fast, smooth and shockless operation of infeed mechanism.
b. Hydraulic Control sensitivity eases the operation of infeed mechanisms.
c. Operator fatigue lessened due to one-position, centralized control.
d. Low maintenance and trouble-free operation of controls.

SEND FOR BULLETIN 78 FOR ADDITIONAL DETAILS

The above case-history is typical of the advantages secured by many Machine Designers and Product Engineers when they use Sperry's single-tube system to solve their remote-control problems.

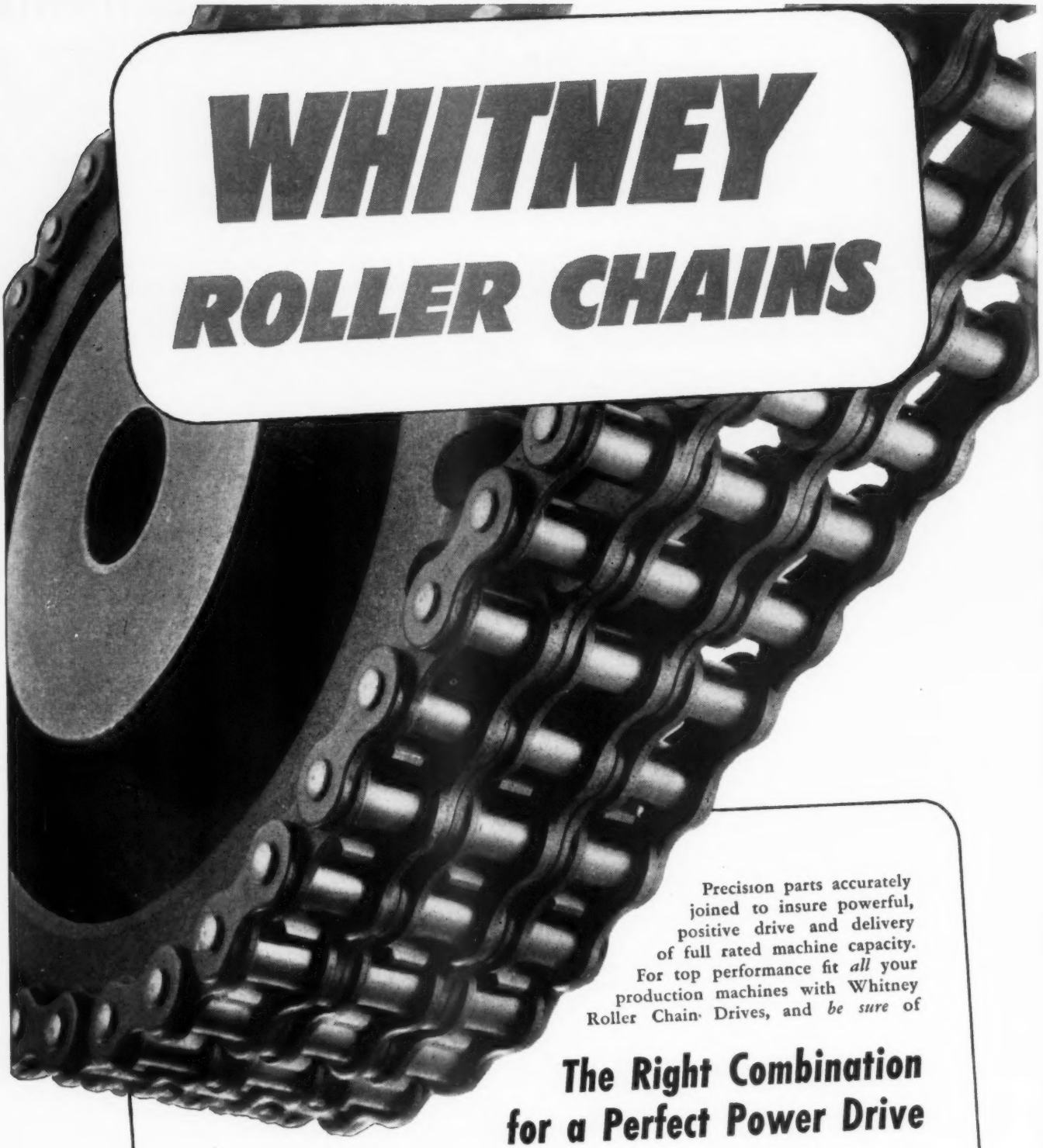
SPERRY

For Scientific Achievement

SPERRY PRODUCTS, INC.

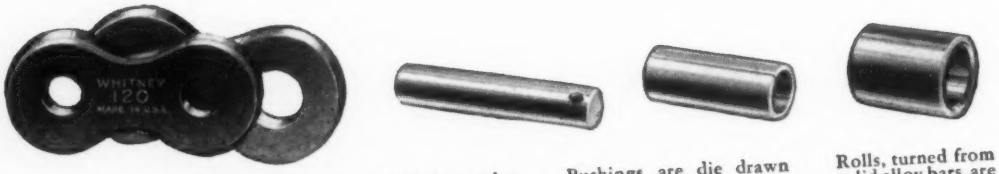
HOBOKEN, N. J. CHICAGO, ILL.

WHITNEY
ROLLER CHAINS



Precision parts accurately joined to insure powerful, positive drive and delivery of full rated machine capacity. For top performance fit *all* your production machines with Whitney Roller Chain Drives, and *be sure* of

The Right Combination for a Perfect Power Drive



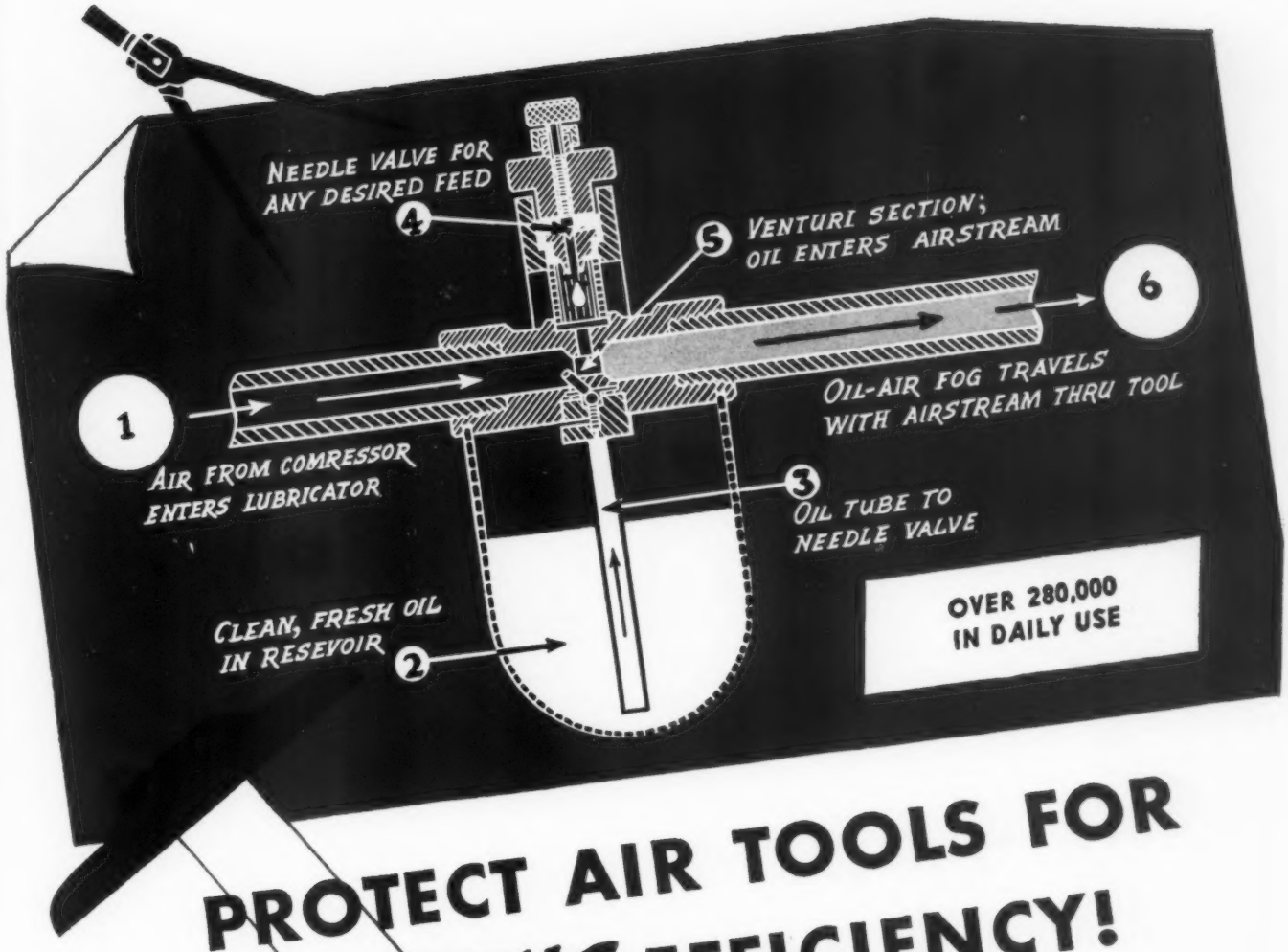
Plates, punched from alloy stock, are heat-treated for maximum strength and toughness.

Pins have high shear value and resistance to wear. They are case hardened and centerless ground.

Bushings are die drawn from selected alloy steels, properly case hardened; held to close limits.

Rolls, turned from solid alloy bars, are heat-treated for toughness.

THE WHITNEY CHAIN & MANUFACTURING COMPANY, HARTFORD 2, CONN.



PROTECT AIR TOOLS FOR *LASTING* EFFICIENCY!

Retain the brilliant performance built into your air driven tools and cylinders. Protect them with positive, continuous, air-borne lubrication. Get peak performance straight thru—with minimum maintenance. Norgren Lubricators are your sure guarantee of such results.

Norgren Lubricators supply exactly the right amount of clean, fresh oil to all moving parts of the air tool or cylinder—for power-packed performance while the tool is operating—for positive protection against rust and corrosion while tool is idle.

With Norgren Lubricators you can't forget vital lubrication—it's automatic. The lubricator runs only when the tool is operating. Responds instantly when air-flow starts. You need not turn it on; you cannot forget to turn it off.

WRITE FOR COMPLETE INFORMATION

[illegible] NORGREN COMPANY, 323 SANTA [illegible] DRIVE, DENVER (11), COLORADO

● When V-Day comes, as come it will, and your thoughts and plans once more turn to peacetime production—remember us. Not for the job we have done in the war... that's been a privilege and a duty... but, rather for the *way* we did that job—with Hydraulics. For in the postwar years Hydraulics are destined to play a mighty role—to revolutionize countless factories and products. So when the war is over and you want to tune up for tomorrow, remember Hydraulics is our business. Our skilled engineers, our production facilities, our "know how" in the field, can assist you greatly in applying the hydraulic principle to your business. Won't you call us in?

WHERE PRECISION COUNTS... HR THIS MARK COUNTS MOST

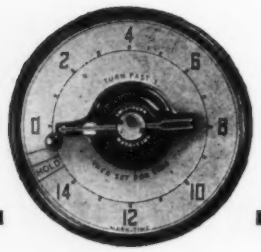
Assurance

A FINISHED PRODUCT reflects the degree of assurance with which the original planning was undertaken. Proper tools help to provide this assurance . . . drawing pencils for example, that assure accuracy of detail, perfect rendering and reproduction.

VENUS Drawing Pencils are engineered to give you drafting perfection without failure: accurately *graded* to assure uniformity in all 17 degrees . . . *strong* in performance . . . *smooth* and *clean* in action.

VENUS *DRAWING PENCILS*

AMERICAN LEAD PENCIL COMPANY, HOBOKEN, NEW JERSEY



We are Furiously Busy Helping to Crush the Japs

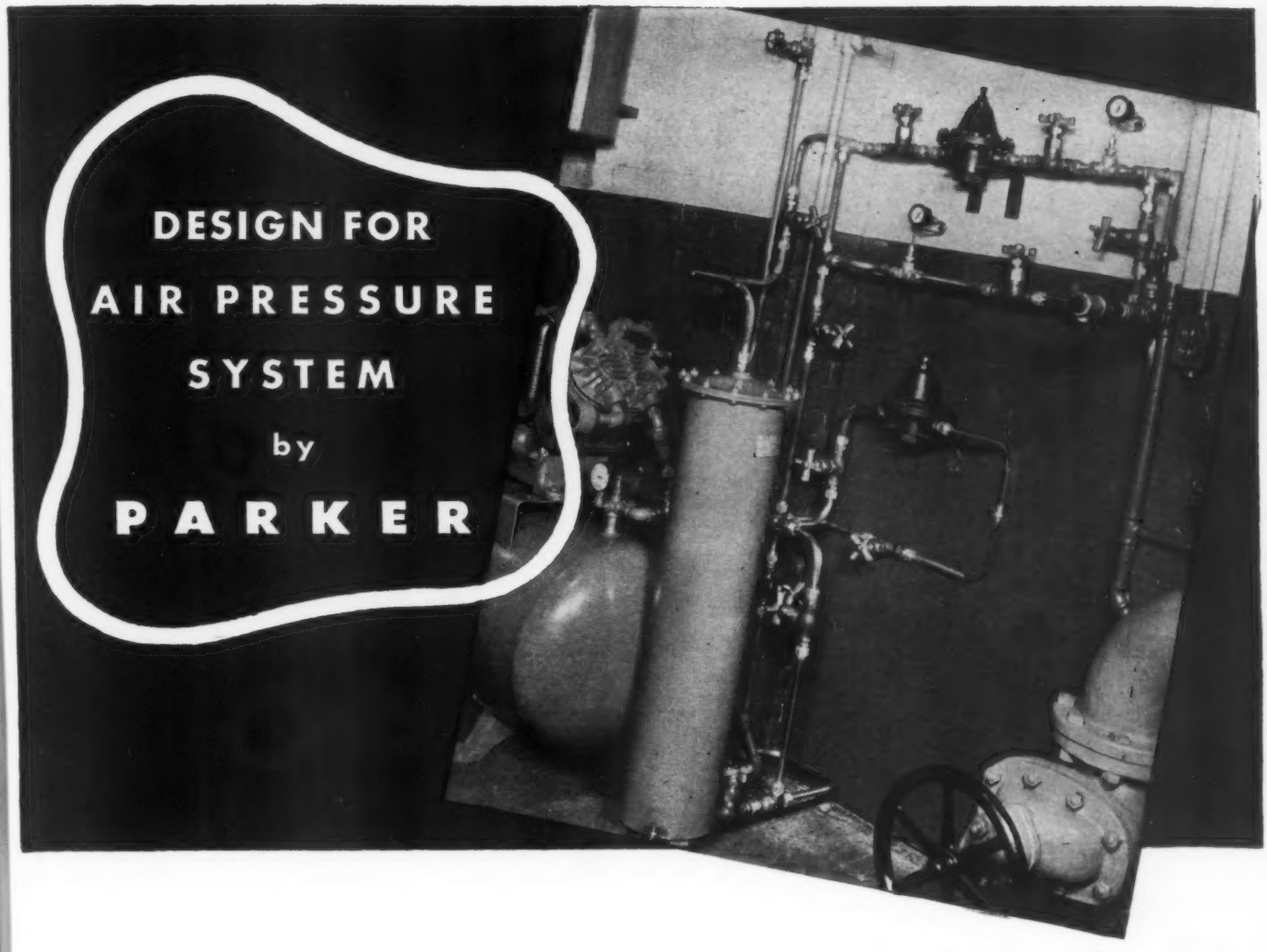
Yet we shall find a way to consult with your engineers about current design problems

ARMY E NAVY

A Mark-Timer is a specialized, simple, rugged, mechanical device for timing (not a clock) that either (1) sounds a signal, or (2) throws an electrical switch.

MARK-TIME
REG. U.S. PAT. OFF.
Timing Devices

M. H. RHODES, INC., 30 Bartholomew Ave., Hartford 6, Conn.



Let's take a frank look at the things that make the controls work—on this air pressure system or on *your* machines.

Here are the specifications for the kind of tubing system that sound Fluid Power Engineering calls for:

Streamlined Flow—for minimum pressure drop, freedom from obstructions and minimum demand on power source.

Space Saving—making best possible use of available space.

Easy Accessibility—for quick and inexpensive service and maintenance.

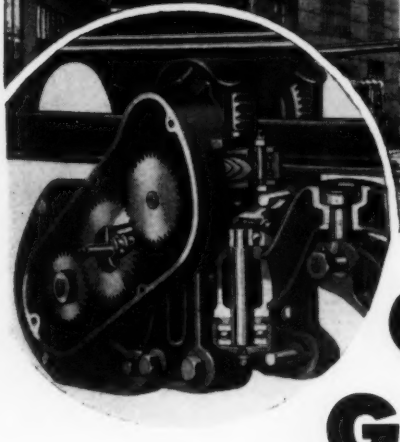
Fewer Joints and Connections—for greater protection against the possibility of leaks, even under conditions of severe vibration, high pressures and abuse.

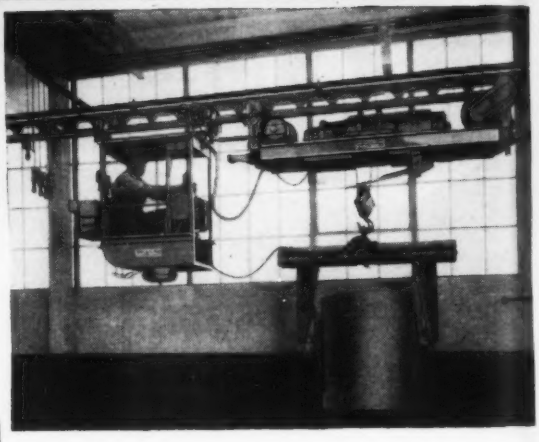
Parker Fluid Power engineers, for more than twenty years, have been designing these systems — for aircraft, motor vehicles, machine tools, refrigeration and process equipment.

We've been building the valves and fittings and the fabricated tubing, for Fluid Power installations, and for fluid transmission.

Whatever you make or plan to make, this broad experience is yours to command. Consult with a Parker engineer, especially in the planning stage. For this service, or for more information, write to The Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

PARKER





OHIO GEARS—

Rate High in Cleveland Tramrail Performance

In war or peace production, wherever Cleveland Tramrail hurries its load high overhead, you'll find Ohio Gears. Ohio Gears play an important part in the smooth, dependable performance of these sturdy material movers.

Smooth operation under shock and strain, proved durability and resistance to wear were some of the characteristics sought by Cleveland Tramrail engineers for use in this unit. Their choice was Ohio Gears. And for some 10 years Ohio Gears have continued to function in this particular Cleveland Tramrail unit.

Cleveland Crane and Engineering Co. is but one of the nationally known companies specifying Ohio Gears as standard on their machines and equipment.

If the dependable operation of your product relies on precision cut, sturdy gears, check the possibilities of Ohio Gears. Their advantages are well worth your consideration.

THE OHIO GEAR COMPANY
1325 EAST 179th STREET • CLEVELAND 10, OHIO

REPRESENTATIVES

*NEW YORK 13, N. Y.
Patron Transmission Co.
129 Grand Street

NEW ENGLAND
George G. Pragst
P. O. Box 995, Pawtucket, R. I.

*LOS ANGELES, CALIF.
J. W. Minder Chain & Gear Co.
927 Santa Fe Avenue

GRAND RAPIDS 8, MICH.
Slaughter Manufacturing Co.
3753 Division Ave. S.

*PITTSBURGH, PA.
Standard Machinists Supply Co.
South 2nd and McKean Street

DETROIT 2, MICH.
George P. Coulter
322 Curtiss Building

*MINNEAPOLIS, MINN.
Industrial Supply Co.
1100 Third Ave., South

BUFFALO 16, N. Y.
F. E. Allen
1315½ Hertel Ave., Room 9

*KANSAS CITY, MO.
Kansas City Rubber & Belting Co.
712 Delaware Street

*SAN FRANCISCO, CALIF.
Adam-Hill Co.
244-246 Ninth St.

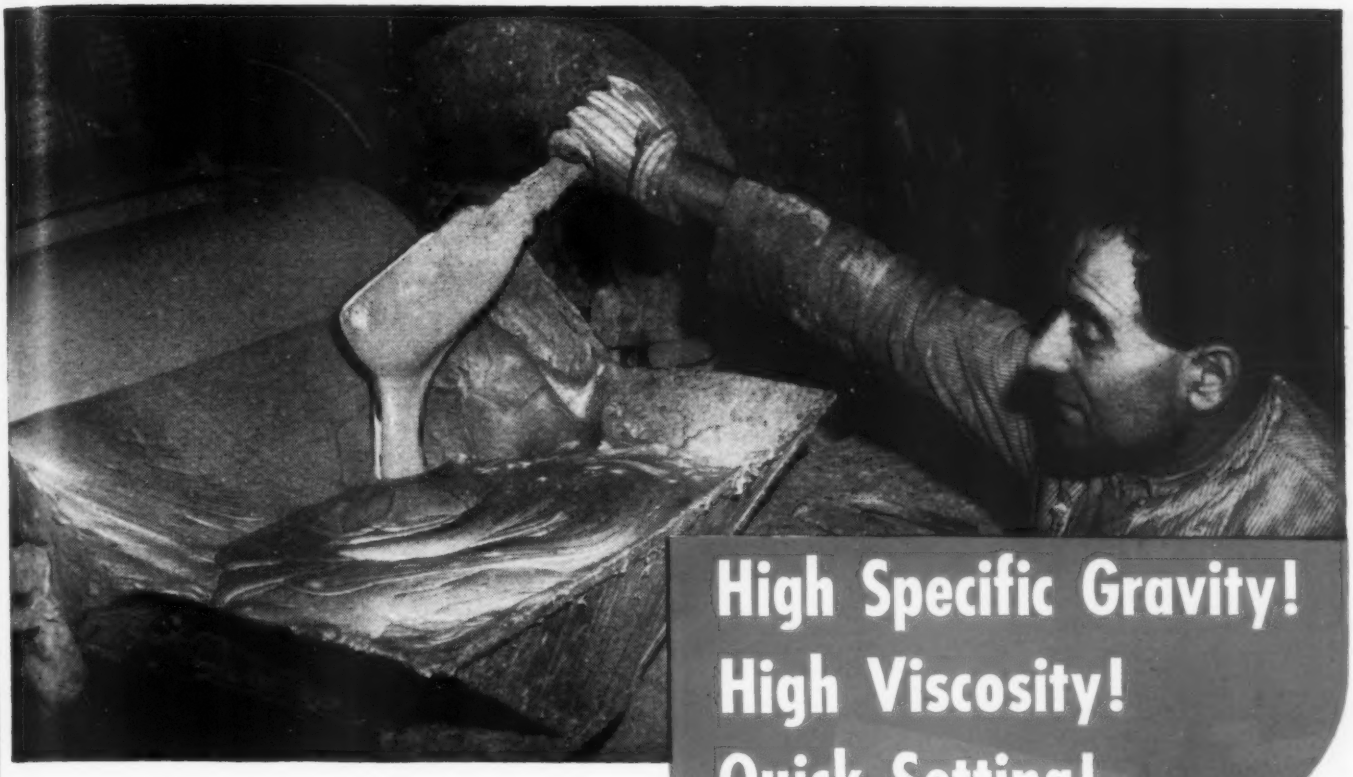
LOUISVILLE, KY.
Alfred Halliday, 330 Starks Bldg.

INDIANAPOLIS 4, IND.
A. R. Young
635 N. Pennsylvania St.

ST. LOUIS, MO.
St. Louis Tool Co.
2319 N. Ninth Street

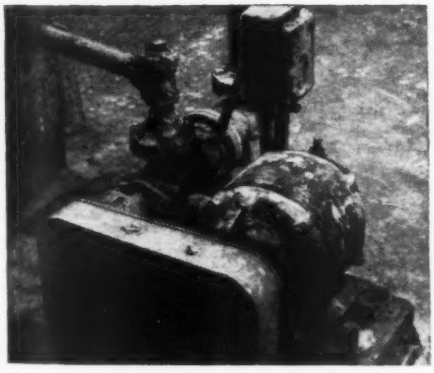
Stocks carried.

OHIO GEARS



High Specific Gravity! High Viscosity! Quick Setting!

The R & M MOYNO pumps this heavy paste *perfectly!*



This belt-driven R & M Moyno pumps finished "flash cream" from rolling mills to hoppers above filling machines at West Disinfecting Company's Long Island City plant. The Moyno pumping principle utilizes a rotor revolving within a stator for positive displacement; locates pumping elements and bearings within separate enclosures. Flash cream as it comes from the rolls is shown in top illustration.

THE STANDARD MOYNO
—One of Many Types

How would you handle this *heavy, viscous paste* that sets-up very stiff in just a few minutes?

Would you carry it in buckets, *by hand?* That was done here, at first—but manual handling proved *far* too slow.

Or would you try to pump this *quick-setting compound?* And, if so, how would you *keep pipes open?*

The problem isn't as tough as it *looks,* if you know about R & M Moyno pumps. There's *nothing* like a Moyno for "impossible" pumping jobs.

PERFORMED PERFECTLY FROM THE START

When the Naval Medical Research Institute, shortly after Pearl Harbor, invited West Disinfecting Company of Long Island City, N. Y., to cooperate in developing a skin-protecting cream, flash burns from exploding enemy bombs and shells were causing 60 to 65 per cent of our major naval engagement casualties. But that day is *long since gone.*

For nearly four years, West has been making "flash cream" for ever increasing Army and Navy demands. And for most of that time the finished cream, *as you see it here,* has been transferred to the tube-filling machines by an R & M Moyno pump.

The Moyno "has *performed perfectly* from the start," delivering this tough-to-pump semi-solid in a *continuous flow,* and with *positive pressure* that always keeps pipes *open.* No matter how stiff the cream becomes it is moved without jamming or delay.

NO OTHER PUMP IS LIKE THE MOYNO

Moyno pumps do the "impossible" because their unique design requires no pistons or valves for *positive displacement,* nor high internal turbulence for *continuous discharge* without pulsation. They handle abrasives in suspension, pass particles, pump practically *anything* that will flow through a pipe. *Thousands* are in service. Here's the *answer* to your pumping problems. Ask us to prove it. Write for literature *today!*

ROBBINS & MYERS • INC. MOYNO PUMP DIVISION • SPRINGFIELD, OHIO
In Canada: Robbins & Myers Co of Canada, Ltd., Brantford, Ont.

MOTORS · HOISTS · CRANES · MACHINE DRIVES · FANS · MOYNO PUMPS · FOUNDED 1878

Simple pneumatic fixture speeds tube cut-off work . . .

This Etna tube cut-off machine is a self-contained unit with a push-button controlled automatic cycle. The work is held stationary and the cutter head revolves. The work holding fixture shown here handles drawn shells which are trimmed to exact length from a shoulder. The Hannifin cylinder (with Hannifin Air Control Valve) operates a collet which grips the work, and the entire fixture moves forward to cut-off position.

Hannifin pneumatic cylinders provide the precision construction with bored and honed cylinder bodies that gets the most from air power. Smooth action, ample power, and simple control contribute to fast production and accurate work.

Write for cylinder and valve bulletin with complete data.

HANNIFIN MANUFACTURING COMPANY
621-631 South Kolmar Ave., Chicago 24, Ill.

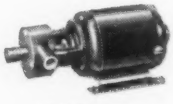
HANNIFIN
PNEUMATIC CYLINDERS

. . . WHICH?

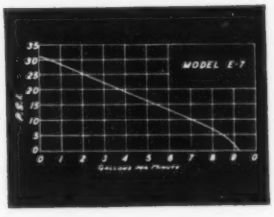
We show two Eastern pumps whose performance characteristics as shown on the charts are quite similar. They are designed for widely differing purposes, however, and the application will determine the type of pump which should be used.

MODEL E-7 SINGLE STAGE CENTRIFUGAL PUMP

. . . is a high speed, light duty model designed for intermittent use . . . where compactness, light weight and minimum size are important factors. As it is equipped with a Universal motor, the pump should not be used near inflammable liquids. This motor has a brush life of 3,000 to 5,000 hours. Equipped with either stuffing box or a mechanical rotary seal. The performance chart of model E-7 is shown here.



MODEL E-7

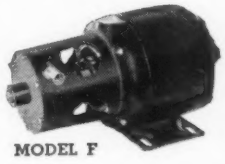


Size: 9" x 4" x 4"
Weight: 8 lbs.
Power: 1/5 H. P.
Motor: General Electric Universal Motor.
Alloys: Available in Cast Iron, Bronze, Stainless Steel, Monel Metal and Hastelloy.

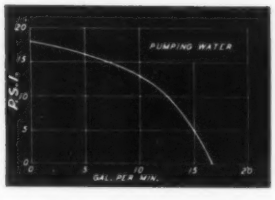
OR?

MODEL F SINGLE STAGE CENTRIFUGAL PUMP

. . . is a heavy duty pump designed for continuous heavy duty industrial use. Powered by a General Electric induction motor for long silent trouble-free operation. Available with either stuffing box or mechanical rotary seal. All motor enclosures, including explosion proof Class I, group D, are available.

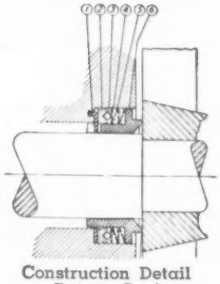


MODEL F



Size: 11½" x 6½" x 6¾".
Weight: 35 lbs.
Power: 1/3 H. P. in semi-enclosed, totally enclosed or explosion proof frames.
Alloys: Available in Cast Iron, Bronze, Stainless Steel, Monel Metal and Hastelloy.

No.	Parts List
1	Lock Washer
2	Synthetic Rubber Packing
3	Coil Spring
4	Flat Washer
5	Spring
6	Seal Body



Construction Detail
Rotary Seal

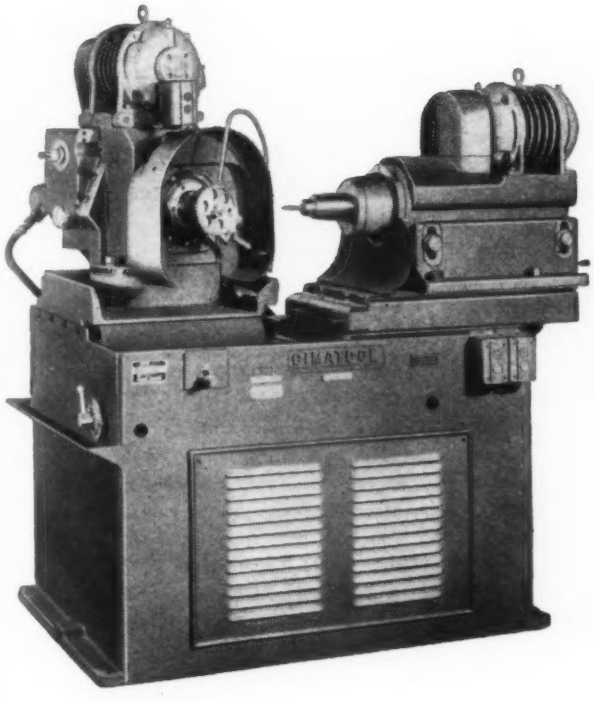
If you need small, highly efficient pumps for industrial uses, Eastern has over 600 variations for your application or will be pleased to design and produce one to meet your specific needs when a reasonable quantity is involved.

EASTERN ENGINEERING COMPANY

56 FOX STREET NEW HAVEN 6, CONN.

High Speed Shock loads?

CONE-DRIVES TAKE THEM EASILY



The ability to maintain smoothness while taking the shock of rapid reciprocations is a direct contribution of CONE-DRIVE gearing to this "postwar" CIMATOOL gear chamfering machine by The SHEFFIELD CORPORATION.

CONE-DRIVE gearing proved its ability to do a better job in such applications as training and elevating drives for all kinds of guns even up to the 16 inchers. Yet, CONE-DRIVE by virtue of its higher load carrying capacity enables a more compact space and weight saving design wherever right angle reductions are required.

If you don't know the story of CONE-DRIVE already and what it can do for your POSTWAR products and equipment, ask for

CW-41B (for Executives)
CW-41A (for Design Engineers)
745 (Post-Graduate Course for Gears)
632 (CONE-DRIVE in Machine Tools)

CONE-DRIVE

CONE-DRIVE DIVISION **MICHIGAN TOOL COMPANY**
7171 E. McNichols Road, Detroit 12, U.S.A.

HYDRAULIC *Pressure Boosters*

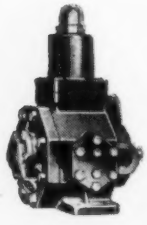
3,000 LBS. P.S.I.

This patented RACINE development will produce the needed higher pressures in your oil hydraulic circuits. It is available in several ratios, as high as 7 to 1. Maximum delivered pressure 3000 lbs. Maximum output 5 G.P.M. A 5 to 1 Unit will automatically convert 25 gallons of oil at 500 lbs. P.S.I. into 5 gallons at 2500 lbs. P.S.I. Ideal for handling peak loads in many pressing and closing operations.

The RACINE Pressure Booster is very compact. Size 10⅛" x 8⅛" x 18". It may be placed anywhere in the circuit. No special foundation needed. Standard low pressure valves may be used. For maximum benefits and Volume Variation use the booster with RACINE "Variable Volume" Oil Hydraulic Pumps. Ask for our Bulletin No. 1404 and also give us an outline of your hydraulic problem.

RACINE Booster Features

- ★ Use any pump—yet develop extra pressure without increase in motor power.
- ★ Compact, simple—No special foundation or supports required.
- ★ Freedom from repairs—No gears to wear or complicated mechanism requiring adjustment.
- ★ Use regular low pressure valves—No special equipment to buy.

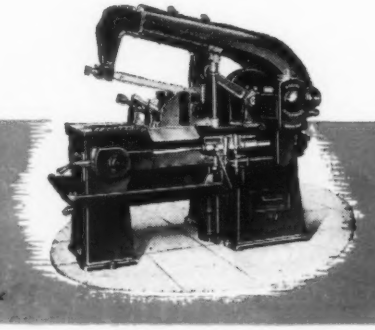


"Variable Volume" Oil Hydraulic Pumps

RACINE "Variable Volume" Pumps are adaptable to a wide variety of uses. They provide smooth, oil-cushioned operation for your products. Available in three sizes, 12, 20 and 30 G.P.M., operating at pressures up to 1000 lbs. P.S.I. This equipment assures maximum flexibility at low operating cost. Fully explained in our Catalog P-10-C. Get your copy today. RACINE TOOL AND MACHINE COMPANY, 1772 State Street, Racine, Wis.

THE PRODUCTION SAWS OF MODERN INDUSTRY

For the high speed cutting of any metal from soft aluminum tubing to hard alloy steel. A full line of machines for general purpose and high production metal cutting work. Capacities 6" x 6" to 20" x 20". Fully explained in our Catalog No. 12.



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RACINE

T-J PERFORMANCE UPS PRODUCTION CUTS COSTS!

● T-J Products have shown outstanding ability to "take it"... performing tough jobs for industry with unbeatable *accuracy, efficiency* and *dependability!*

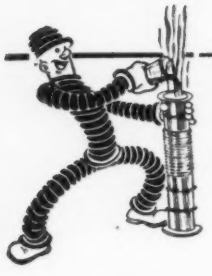
That's why more and more practical production men *specify* T-J where there's a job for Rivitors ... hydraulic cylinders ... or air cylinders ... cutters ... Clinchors ... or air controls. All T-J Products expertly engineered ... precision-built ... rigidly inspected ... right in every respect! Send for latest bulletins. The Tomkins-Johnson Company, Jackson, Michigan.

REX-FLEX

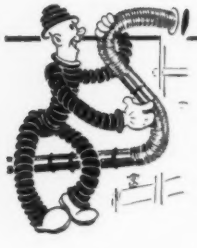
RESISTS { heat / corrosion / vibration

Wherever corrosion, excessive vibration, and heat are factors—alert production men choose REX-FLEX stainless steel Flexible Metal Tubing. For it effectively resists corrosion—has the extreme temperatures of stainless steel . . . the extra flexibility to withstand prolonged vibration . . . and is formable for use for virtually any application.

In scores of general and heavy industry jobs—REX-FLEX is minimizing flexible metal tubing connection failures, delivering topnotch performance. Find out what it can do for you. Write today for full information.



REX-FLEX—has all the outstanding corrosion-resistant qualities of 18-8 Austenitic Stainless Steel . . . safely handles many types of corrosive liquids and gases. In addition, it's pressure-tight—so there's no dangerous, wasteful leakage.



REX-FLEX—is easier to install, for it is manually bendable in multiple planes. Flanges and fittings are seam welded to form uni-metal assembly. This eliminates the hazards of solder—insures uniform strength and pressure-tightness wherever joints are necessary.

REX-FLEX—is available in 5 wall formations, unbraided or braided. Sizes range from 5/16" to 6" I.D. (incl.). The C.M.H. line of stainless steel units also includes REX-FLEX Inner Lined Exhaust Members and C.M.H. Bellows.

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CMH CHICAGO METAL HOSE CORPORATION
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Plants: Maywood and Elgin, Ill.

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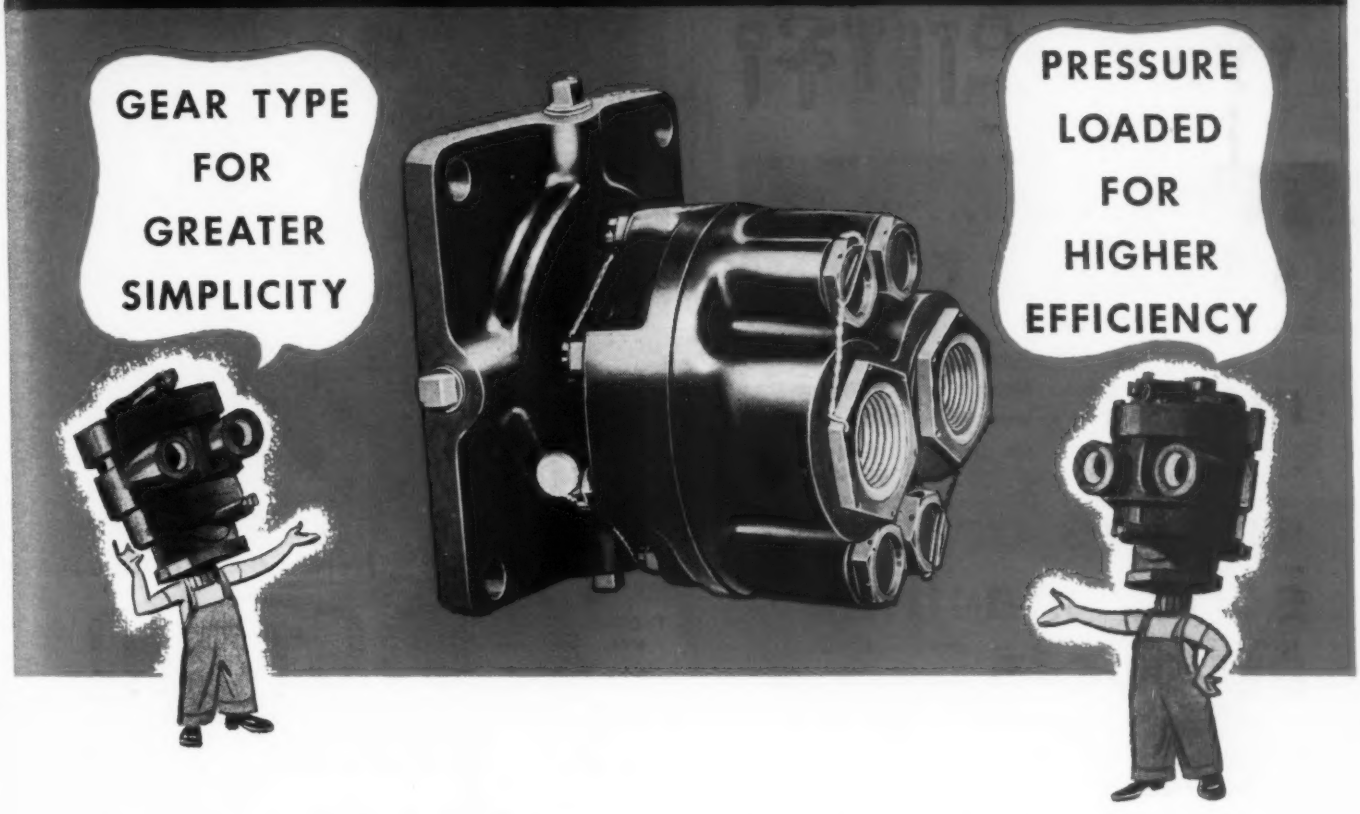
Pesco ENGINE DRIVEN HYDRAULIC PUMPS



● Outstanding performance. Dependability beyond the ordinary. That's the record of PESCO Engine Driven Hydraulic Pumps in modern aircraft.

PESCO designed these pumps especially to meet the exacting needs of aircraft hydraulic systems. For greatest simplicity there's improved gear type construction that reduces working parts to a minimum. That means greater dependability, longer life, less service and maintenance.

And through *Pressure Loading*, an exclusive PESCO development, high efficiency is maintained through a wider range of operating conditions. PESCO *Pressure Loading* compensates for wear and thermal variations encountered in high altitude flight to maintain minimum end clearance between pump gears and gear housing.

Models are available with pressure limits up to 3000 p.s.i. Capacities up to 12 g.p.m. Weights from 2.5 to 10 lbs.

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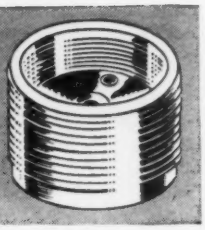
PESCO advanced design and performance extend through a complete line of air, vacuum, fuel and hydraulic pumps . . . precision equipment meeting practically all aircraft needs for controlled liquid flow and Pressurized Power.

In Aircraft Hydraulics, Fuel Pumps, Air Pumps, Related Accessories . . .
PERFORMANCE POINTS TO Pesco FIRST

Any size... to



type...

length.....
strength....

metal...

Stainless Steel	Carbon Steels
Aluminum	Non ferrous Alloys
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screws or screw machine products

Waltham Screw Company's spread of production includes the almost microscopic .025 size set-screw for delicate precision watch-making, varying sizes of screws for use with metals, plastics . . bolts, nuts, — in fact, the greatest variety of special products up to 1⅛" diameter for specific uses.

- Accuracy in all steps of production insures precision in all applications.
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- Specific problems requiring special screw machine products are welcomed.

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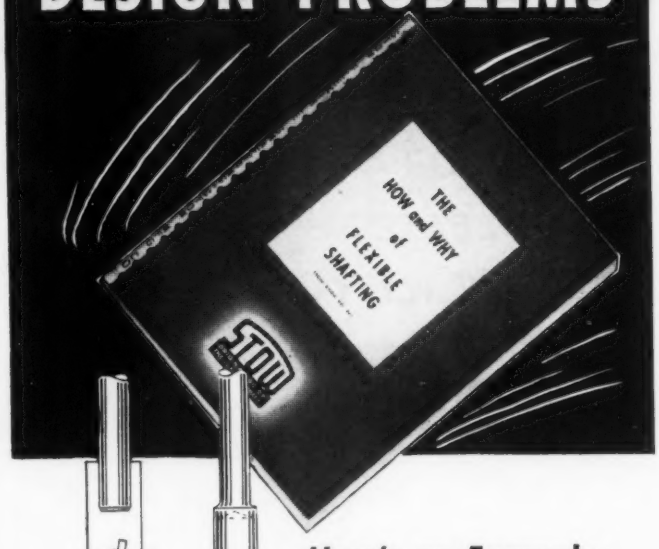
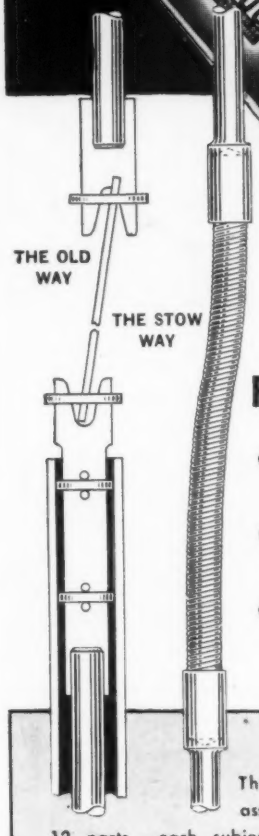
Out of the Pages of This Book

Come Solutions to hundreds of DESIGN PROBLEMS





Here's an Example:

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- **Cuts manufacturing and assembly costs!**
- **Eliminates gearing and universal joints!**
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The original assembly had 12 parts — each subject to wear, service, and replacement. The STOW Way substitutes one simple flexible coupling. Saves material, labor, upkeep! Eliminates noise!

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STOW MANUFACTURING CO.
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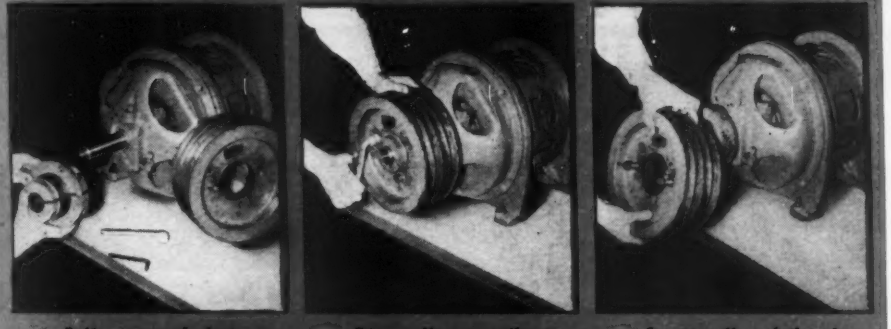
STUBBORN old-style sheaves

vs. EASY-GOING QD SHEAVES

If you've watched maintenance and operating men put on and take off conventional type sheaves, especially when they have a tight fit, you've heard them groaning over their tough job. Now, you can turn their groans to grins by specifying Worthington QD Sheaves. Revolutionary in design, they eliminate the need for sledge hammers, crowbars, jacks . . . save time in getting sheaves on and off. In fact, they're as —

Easy as A B C to get on and off . . .



A Split, tapered hub is easy to lift, slide on shaft and align. Cap screw in flange maintains alignment.

B Rim pulls up easily on shaft for tapered friction fit on hub . . . positive press fit of hub on shaft.

C Large pull-up bolts also serve as jackscrews to release rim's grip on hub for easy removal.

For further proof that *there's more worth in Worthington,* write your nearest Worthington Distributor, district office or *Worthington Pump and Machinery Corporation, Standard Products Division, Harrison, N. J.*

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Easy to get on . . . Easy to get off . . .
Yet always tight on the shaft

WORTHINGTON
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With this Worthington Multi-V-Drive Master Manual in your files you have at your fingertips all the information you need to select the right drive for any application. So complete is the data and so clearly indexed you can find that drive in less than 3 minutes.

Especially interesting to design engineers are such studies as the effect of tension, sheave diameter and centrifugal force on the life of Multiple-V-Belts; the right and wrong ways to install, adjust and maintain them; minimum and recommended sheave diameters, etc.

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You can have a Worthington Multi-V-Drive Master Manual by return mail. Write today on your company letterhead. *Worthington Pump and Machinery Corporation, Standard Products Division, Harrison, N. J.*

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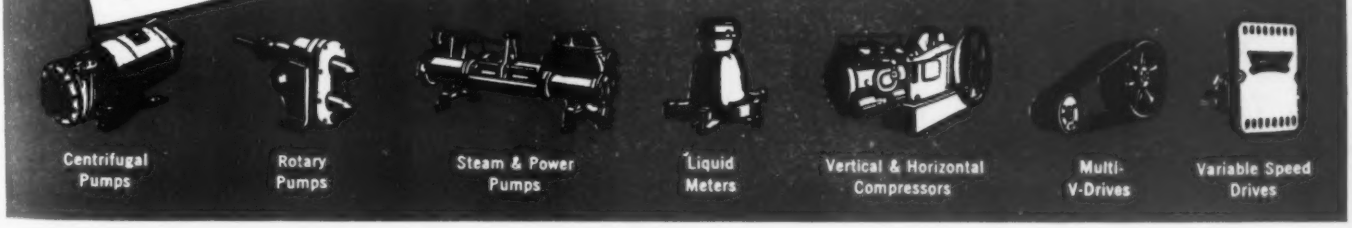
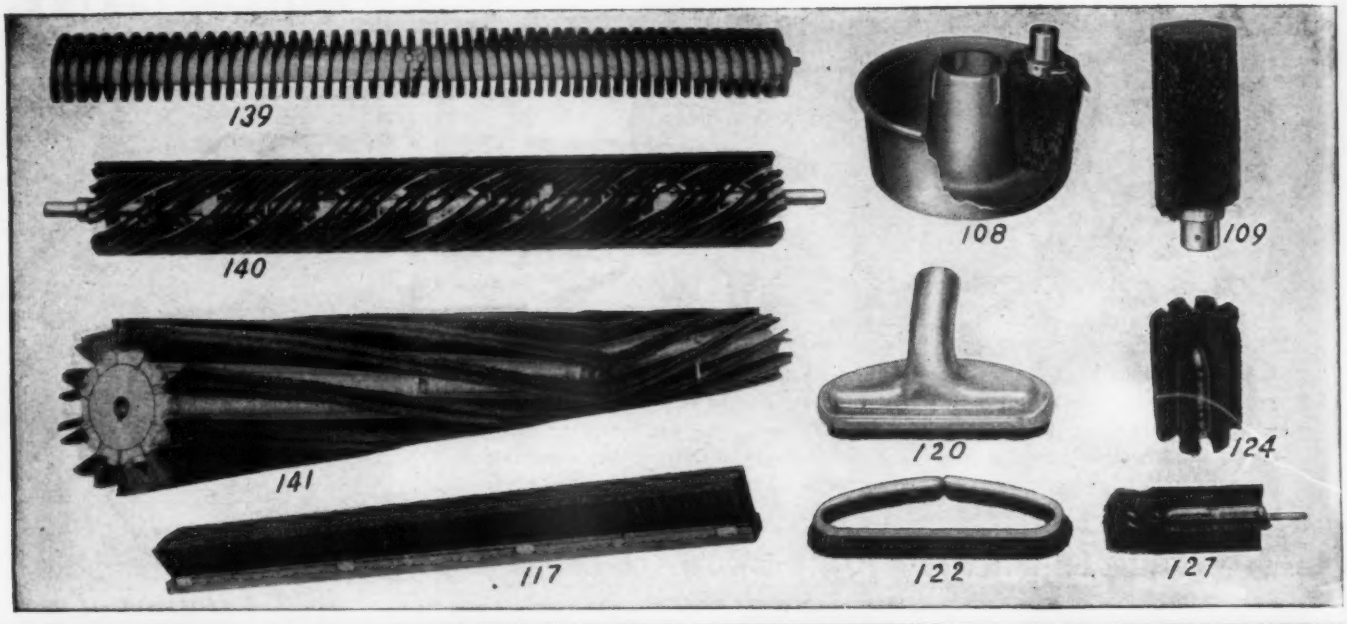
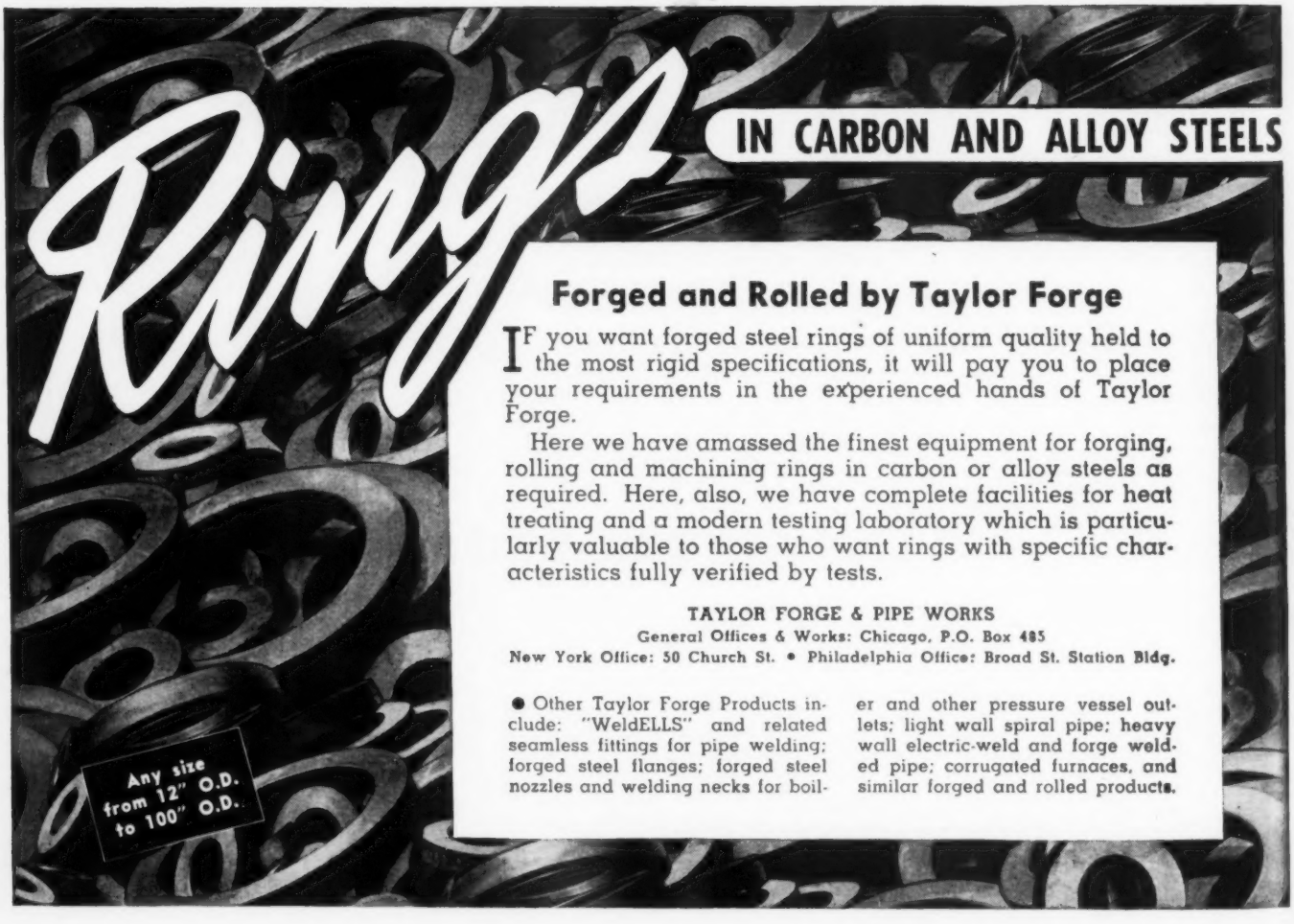


FULLERGRIPT BRUSHES *for* INDUSTRY

Made in continuous ridged metal backing—full radial spiraled, semi-spiraled, straight or shaped built for that new machine design. Adopt permanent metal arbors or holders that operator can renew with Fullergript brush strips.



THE FULLER BRUSH COMPANY
INDUSTRIAL DIVISION, 3590 MAIN STREET, HARTFORD 2, CONN.



Forged and Rolled by Taylor Forge

IF you want forged steel rings of uniform quality held to the most rigid specifications, it will pay you to place your requirements in the experienced hands of Taylor Forge.

Here we have amassed the finest equipment for forging, rolling and machining rings in carbon or alloy steels as required. Here, also, we have complete facilities for heat treating and a modern testing laboratory which is particularly valuable to those who want rings with specific characteristics fully verified by tests.

TAYLOR FORGE & PIPE WORKS
General Offices & Works: Chicago, P.O. Box 485
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● Other Taylor Forge Products include: "WeldELLS" and related seamless fittings for pipe welding; forged steel flanges; forged steel nozzles and welding necks for boiler and other pressure vessel outlets; light wall spiral pipe; heavy wall electric-weld and forge welded pipe; corrugated furnaces, and similar forged and rolled products.

MACHINE DESIGNERS CAN TAKE A TIP FROM THE USE OF OILGEAR TRANSMISSIONS IN AMERICA'S NEWEST, MOST EFFECTIVE ANTI-AIRCRAFT GUN

A typical example of the almost unlimited flexibility of Oilgear Fluid Power, the things you can do with it, is the highly successful use of Oilgear Transmissions in America's newest and most effective 40 MM anti-aircraft guns. Two Oilgear Transmissions serve each gun. One moves the carriage from side to side, the other elevates the gun muzzle. The two transmissions are self-synchronizing and work automatically on signals from the director-mechanism. Enemy planes may come in from any direction, at tree-top level as well as at great heights. Hence, these Oilgear Transmissions provide rapid slewing and elevating speeds with precise, rapid and accurate deceleration as the gun centers on the target, and appropriate following speed. Plane evasive tactics are met by variable synchronization of the two directions of travel. Easy and speedy disengagement and re-engagement of automatic operation is also provided. These Oilgear transmissions are small, powerful, dependable.

In the functions outlined above, or elsewhere in the wide range of characteristics of Oilgear Fluid Power you are almost certain to find a better solution to the problem that confronts you. Write for further information or put your problem up to Oilgear Engineers. Do it *now*. . . . THE OILGEAR COMPANY, 1311 West Bruce Street, Milwaukee 4, Wisconsin.

External view of Oilgear new, smaller, efficient, high speed transmissions as used on newest 40 MM anti-aircraft gun control system which also incorporates travel limit switches, unlimited azimuth angle and increased elevation angle, push-button controlled high-speed slewing, increased torque and speed of operation.

ARE YOU TRYING TO:

1. Apply large forces through long . . . or short . . . strokes at variable speeds? **2.** Obtain automatic work cycles, variable speeds in either direction . . . with or without pre-set time dwell? **3.** Apply large forces through continuous or intermittent reciprocating cycles at constant or variable velocities? **4.** Obtain extremely accurate control of either position or speed of a reciprocating member? **5.** Apply accurately variable pressure either static or in motion? **6.** Closely synchronize various motions, operations or functions? **7.** Apply light . . . or heavy . . . forces at extremely high velocities through either long or short distances of travel? **8.** Obtain continuous automatic reversing drives at constant R.P.M. or over a wide range of speed variation? **9.** Obtain accurate remote control of speed and direction of rotation, rates of acceleration and/or deceleration? **10.** Obtain constant horsepower output through all or part of a speed range? **11.** Obtain automatic torque control? **12.** Obtain accurately matched speed of various rotating elements? **13.** Obtain constant speed output from a variable speed input? **14.** Obtain full pre-set automatic control, elimination of problems of shock, vibration, etc.?

You Need Oilgear!

OILGEAR
Fluid Power

This HARRY FERGUSON, INC.
3/4 TON
TWO WHEEL WAGON
is
WHEELED by French & Hecht
STRENGTH FOR GENERAL FARM JOBS
SPEED FOR AUTOMOBILE HIGHWAY TRAVEL

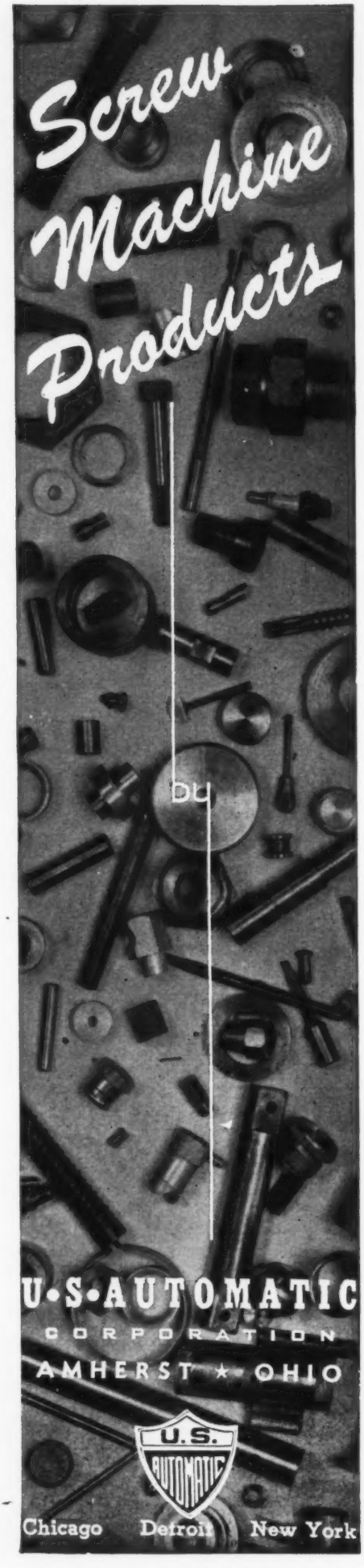
A Hundred Uses Throughout the Year

THE disc wheels upon which this sturdy Ferguson Wagon is mounted are designed to take the punishment offered by a wide variety of jobs under as many conditions. IN THE FIELD, hitched to the tractor it permits quick transport of implements, grain or forage, fencing material, etc. over any ground the tractor can negotiate. ON THE HIGHWAY, hitched to auto or light truck it permits speedy travel to town and back with whatever is to be carried.

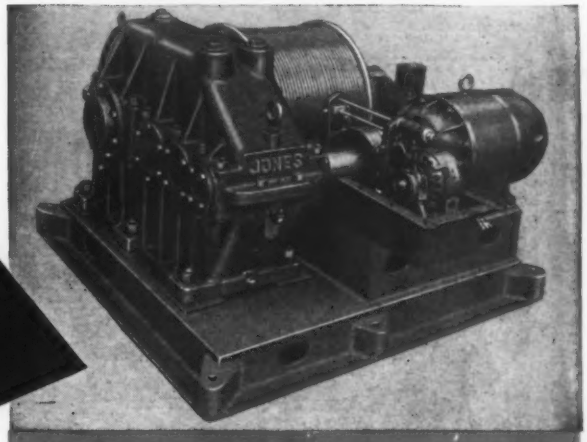
French & Hecht ENGINEERS can aid you in DETERMINING the JUST RIGHT CAST SPOKE PRESSED WHEELS for YOUR REQUIREMENTS

Thus, again, French & Hecht engineers have provided a wheel with the GUTS for heavy work and the SPEED for fast travel.

F&H WHEELS ARE IMPORTANT
FRENCH & HECHT, INC.
SUBSIDIARY of KELSEY-HAYES WHEEL CO.
DAVENPORT, IOWA
Wheel Builders Since 1888



When the drive is built into the unit



● Jones Skip Hoist Drive built as a complete unit by the Jones organization in several types with base to take any motor specified by the purchaser. This drive is equipped with all the modern protective devices such as cam or nut type limit switches, solenoid or disc type brakes and slack cable switches. The drives are single, double or triple reduction Jones Herringbone Speed Reducers.

FOR many years the Jones organization has been developing various types of drive units in which Jones special or standard speed reducers form an important integral part of the unit.

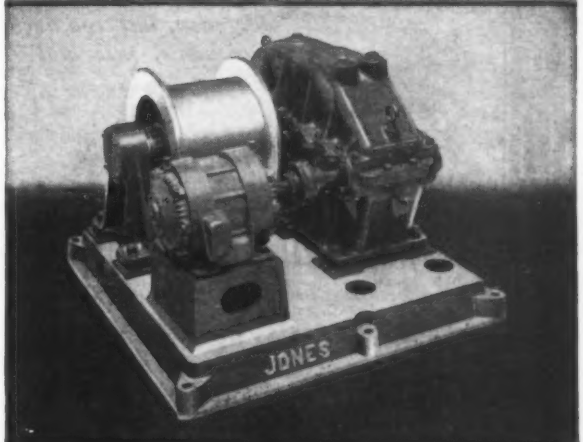
The car puller, door hoist and skip hoist drives illustrated and described here are typical specimens of Jones Unit Drives. These machines are built as complete units by the Jones organization with base to take any motor specified by the purchaser.

The Jones organization has also worked with a great many manufacturers in the application of Jones gears and speed reducers to an extremely wide variety of complete assemblies. You are invited to make full use of this experience in connection with any power transmission problems that you may have.

● Jones door hoists are built in many ratings and may be installed with almost any convenient arrangement of sheaves and cables. Base will take any standard motor. No limit switches of any kind are required with this unit.

W. A. JONES FOUNDRY & MACHINE CO.
4417 W. Roosevelt Road
Chicago, Illinois

Bulletin No. 80, "Jones Drives for Industry", may be helpful in giving you a complete picture of the Jones products, engineering services and manufacturing facilities that are available for helping you solve your drive problems.



● A complete Jones car puller unit. These outfits are for use with wire rope and are manufactured in a wide range of capacities to suit the number of cars to be handled in each plant.

Jones

HERRINGBONE—WORM—SPUR—GEAR SPEED REDUCERS · PULLEYS
CUT AND MOLDED TOOTH GEARS · V-BELT SHEAVES · ANTI-FRICTION
PILLOW BLOCKS · FRICTION CLUTCHES · TRANSMISSION APPLIANCES

VERSATILITY...
special parts in any metal

The most efficient functioning of a special part in your product often depends upon the metal used. Our engineers will be glad to help you at no obligation on your part. We are equipped to cold-forge special parts in any metal, and in a wide variety of finishes. And costs for cold-forged parts are usually less.

This Decimal Equivalents wall chart is accurate to four places and signalled in three colors. Yours at no cost or obligation. Just send us your name, title and address.

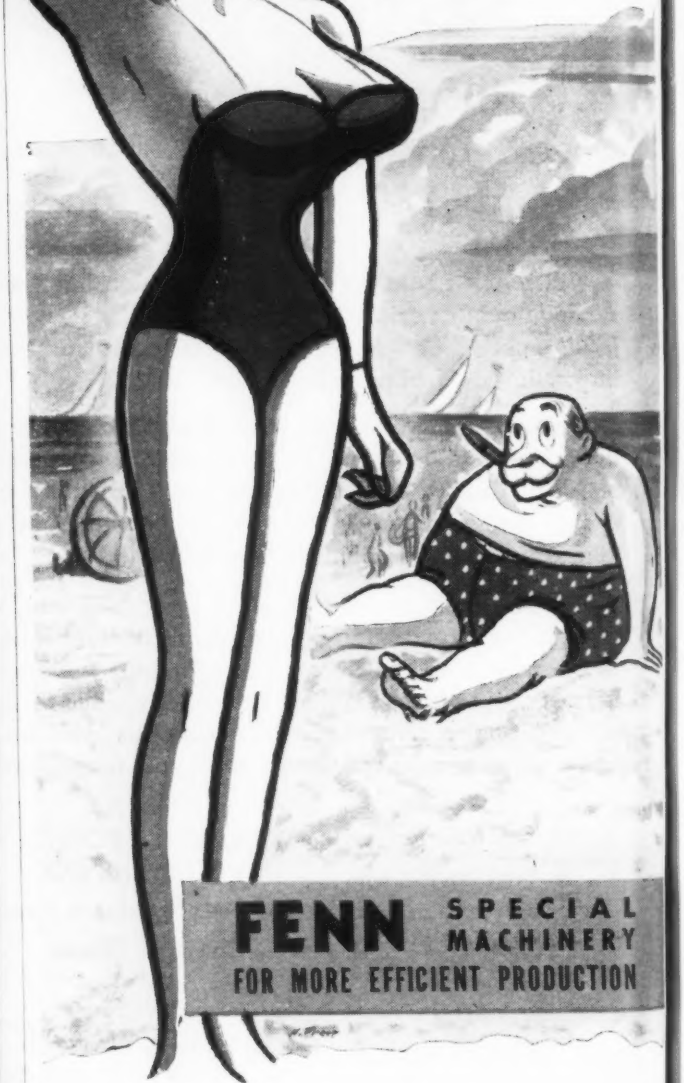
See our Catalog in Sweet's File for Product Designers

JOHN HASSALL, INC.
Specialists in Cold-Forging Since 1850
402 Oakland St., Brooklyn 22, N. Y.

SPECIAL NAILS RIVETS SCREWS
Hassall

"DESIGN IS ALL IMPORTANT, EVEN IN A BATHING SUIT," EXPLAINED MISS DINGLE

-how much more so when it comes to the design of special machinery.



FENN SPECIAL MACHINERY
FOR MORE EFFICIENT PRODUCTION

Fenn Special Machinery is custom-built to meet the user's individual needs . . . automatic and semi-automatic to speed up operations as well as eliminate hand operations. Fenn builds the tools as well as the machines — one responsibility. Plan for profits with Fenn.

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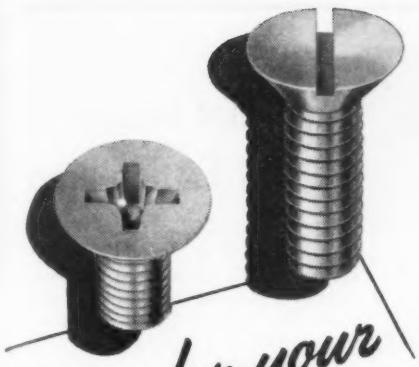


Also-for your Standard Parts come to CORBIN

Greater accuracy is a *Plus* for industrial buyers of screws and nuts . . . and a Corbin habit, because we are geared to work in tenths . . . but *fast*. That's why even our Standard Machine Screws pass every test for flawless uniformity.

Look to CORBIN
for your requirements in Screws and Nuts . . . a full range in both CORBIN-PHILLIPS and Regular Slotted. Also AIRCRAFT Screws and Nuts to Governmental specifications.

See your Distributor
— also complete stocks at Chicago, New York and New Britain . . . and sales representatives who can "talk shop."

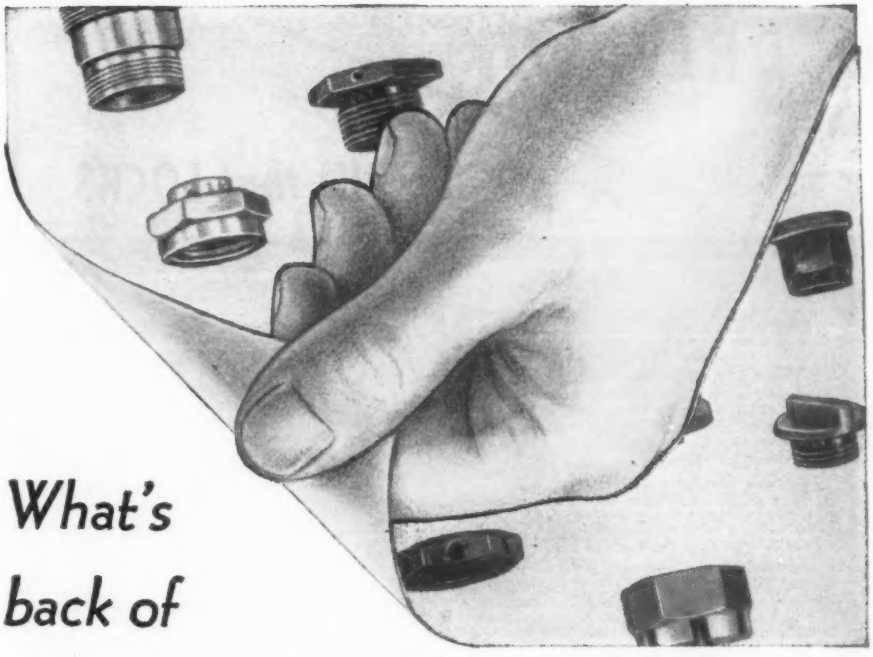
S-13

M³ MEN MATERIALS MACHINES **facilities**

that have made Corbin Headquarters for Precision Parts are producing highest quality Screws . Nuts . Chain.

Look to Corbin for

Standard Parts



What's back of your Precision Parts Contractor?

Will he be able to meet all your requirements? For instance: a schedule that doubles or triples overnight; a change in precision finish or material that requires new manufacturing methods (grinding instead of machining); a completely new set of blueprints and specifications to be followed on short notice . . .

None of us can look into the future very far, but *we* can point to many years' experience as *precision headquarters*, during which time we have built up an organization of men, materials and machines geared to high production and rapid change-over in this exacting work.

Look to Corbin for your Precision Parts and face the future calmly!

Facilities are explained in this bulletin — which you will find in Sweet's File 4m10 for Product Designers. If you prefer that we send you a copy, please request it on your letterhead.

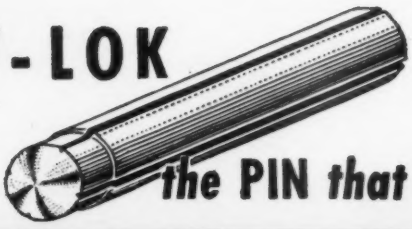
P-4

THE CORBIN SCREW CORPORATION
The American Hardware Corporation, Successor
NEW BRITAIN CONNECTICUT

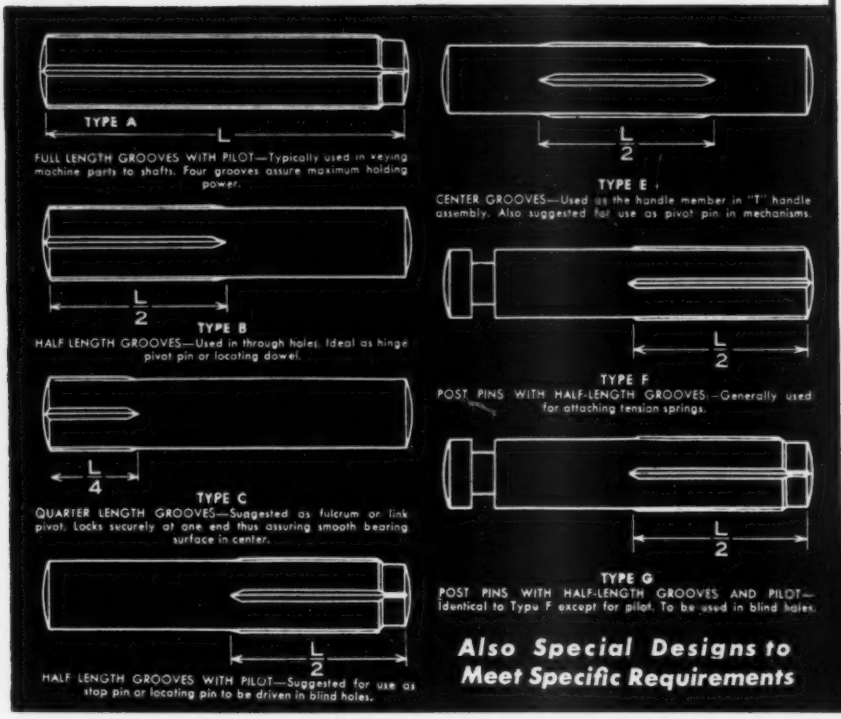
See Sweet's Product Design Catalog, outline of Corbin Products and Facilities

CORBIN *Precision Parts*

DRIV-LOK



the PIN *that* LOCKS


TYPE A
L
FULL LENGTH GROOVES WITH PILOT—Typically used in keying machine parts to shafts. Four grooves assure maximum holding power.
TYPE B
L/2
HALF LENGTH GROOVES—Used in through holes. Ideal as hinge pivot pin or locating dowel.
TYPE C
L/4
QUARTER LENGTH GROOVES—Suggested as fulcrum or link pivot. Locks securely at one end thus assuring smooth bearing surface in center.
L/2
HALF LENGTH GROOVES WITH PILOT—Suggested for use as stop pin or locating pin to be driven in blind holes.
TYPE E
L/2
CENTER GROOVES—Used as the handle member in "T" handle assembly. Also suggested for use as pivot pin in mechanisms.
TYPE F
L/2
POST PINS WITH HALF-LENGTH GROOVES—Generally used for attaching tension springs.
TYPE G
L/2
POST PINS WITH HALF-LENGTH GROOVES AND PILOT—Identical to Type F except for pilot. To be used in blind holes.

Also Special Designs to Meet Specific Requirements

Will not loosen —Vibration-proof

DRIV-LOK Pins answer "a hundred" connecting and anchoring problems, for driving into a standard hole; they will not loosen even under continuous vibration or repeated shock.

With bodies of specified diameters, each has four flutes with raised (oversize) edges along its binding or anchoring section. When driven into a drilled hole, these work hardened edges are slightly compressed. This deformation creates a steady and unyielding outward pressure of the flute edges against the walls of the hole.

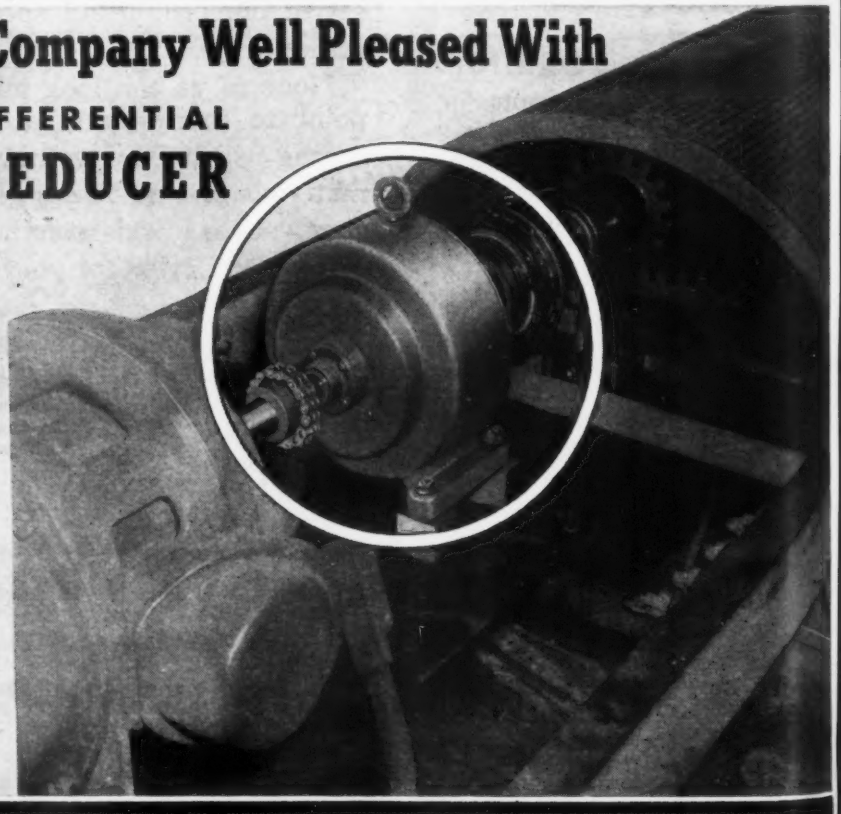
DRIV-LOK pins come (standard) in type illustrated and in many special designs, in many materials and diameters. All can be delivered promptly.

To date our capacity has been taken for war requirements, but since we have no reconversion problems, we are ready at any time to deliver a few test samples or millions for post war production. *Write for Catalog.*

THE DRIV-LOK PIN CO.
561 W. Washington Blvd.
Chicago 6, Illinois

Prominent Rubber Company Well Pleased With

WHS **Patented DIFFERENTIAL**
SPEED REDUCER



Used on Drive for Clothing Cement Line . . . Operating 4 Churns

Again the extreme **compactness, versatility** and **dependability** of this Differential Reducer have been demonstrated. Ratios of 3 to 1 or 30,000 to 1 and greater in the same housing . . . . quiet-running **Helical Gears** . . . from 88% to 95% efficiency . . . are a few of many features.

MEMBER OF AGMA

Manufactured by the "Makers of the First Speed Reducers in America to be Shipped from Stock." Send for catalog.

WHS

WINFIELD H. SMITH, Inc.
111 EATON STREET, . . . SPRINGVILLE . . . ERIE COUNTY . . . NEW YORK

GEARGRIND Production

The Closest Approach to Perfection

GEARGRIND Machines give you both production and the tolerances required by modern engineering. Low overall production costs reflect the accuracy that practically eliminates rejects and provides the fine finish that makes many operations unnecessary.

We manufacture a complete line of "GEARGRIND" Machines for the Formed Wheel Grinding of external and internal gears, internal involute splines, straight splines, racks and serrations, as well as special machines for special grinding operations.

CATALOG ON REQUEST
Covers all GEARGRIND Machines and Contract Grinding Service.

GEARGRIND TYPE GG-24-48
Handles external gears up to 24" diameter.
Takes up to 48" between centers.
Complete specifications in catalog.

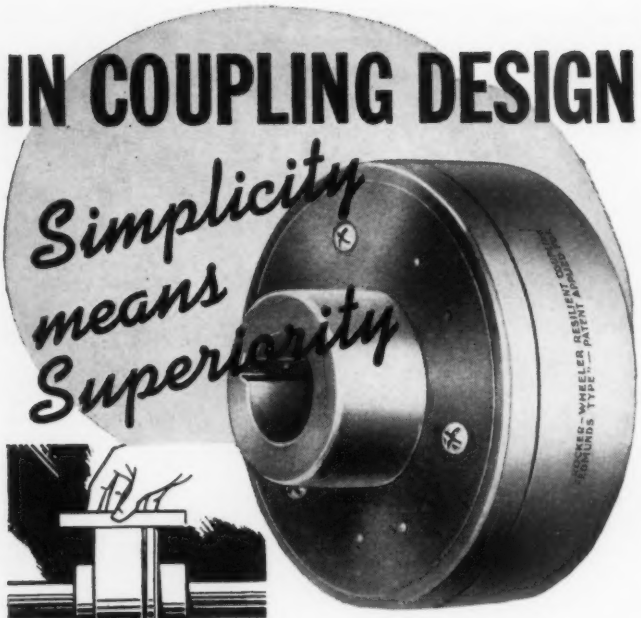
The GEAR GRINDING MACHINE COMPANY
DETROIT 11, MICH. U.S.A.

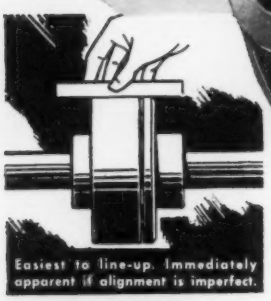
ARMY E NAVY

Manufacturers of RZEPPA Constant Velocity Universal Joints

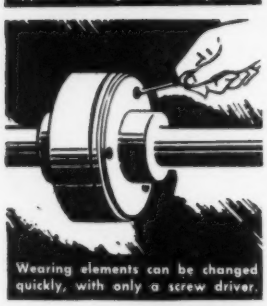
IN COUPLING DESIGN

Simplicity means Superiority

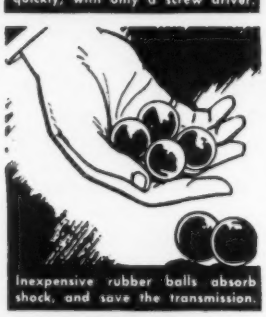




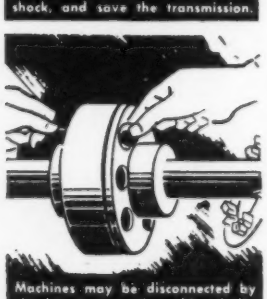
Easiest to line-up. Immediately apparent if alignment is imperfect.



Wearing elements can be changed quickly, with only a screw driver.



Inexpensive rubber balls absorb shock, and save the transmission.

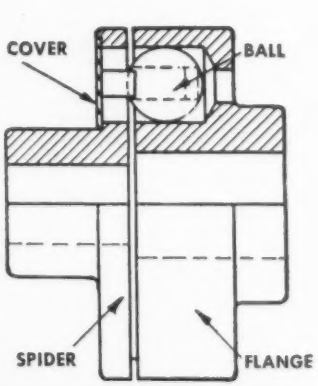


Machines may be disconnected by simply removing the rubber balls.

The Crocker-Wheeler resilient flexible coupling consists of a spider, a flange, a ball retaining cover and six synthetic rubber balls—that's all there is to it! And yet, this is more than just a *trouble-free* coupling—it actually adds years to the life of both the driving and driven machines.

The balls transmit torque, absorb shock and vibration, yet do not transmit end thrust. If *serious* misalignment occurs after installation, neither the machines nor the coupling will be harmed. The only damage will be to the rubber balls, which can be replaced at negligible cost, in one or two minutes. Under normal service conditions the balls last for years without renewal.

Available for shaft diameters up to 8", these couplings require no lubrication, no maintenance of any kind. Write for prices, dimensions, descriptive information. No cost, no obligation. Address the Crocker-Wheeler office nearest to you.

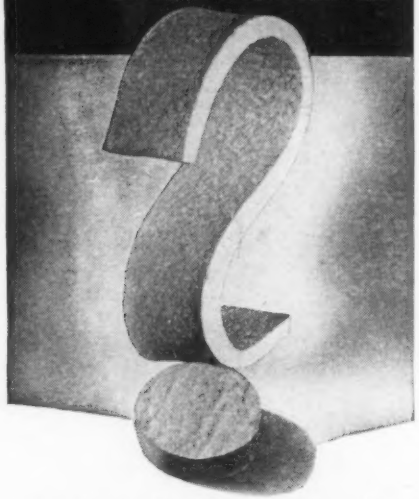


CROCKER-WHEELER

A Division of JOSHUA HENDY IRON WORKS
AMPERE, N. J.

BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • LOS ANGELES
DETROIT • NEW YORK • PHILADEPHIA • PITTSBURGH • SAN FRANCISCO • WASHINGTON

How strong CAN *felt* BE MADE



TENSILE breaking strength as great as 1016 pounds per 2-inch width was observed during laboratory tests of 2″ x 10″ strips (0.375″ to 0.5″ thick) of six different Booth felt types.

Almost any desired combination of qualities . . . durability is only one . . . are obtainable through the *controlled* manufacture of Booth "prescription" felts and precision die-cutting into mechanical parts. Read Booth's "Technique of Felt Making."

THE BOOTH FELT COMPANY
475 19th Street Brooklyn, N. Y.
736 Sherman Street Chicago, Ill.

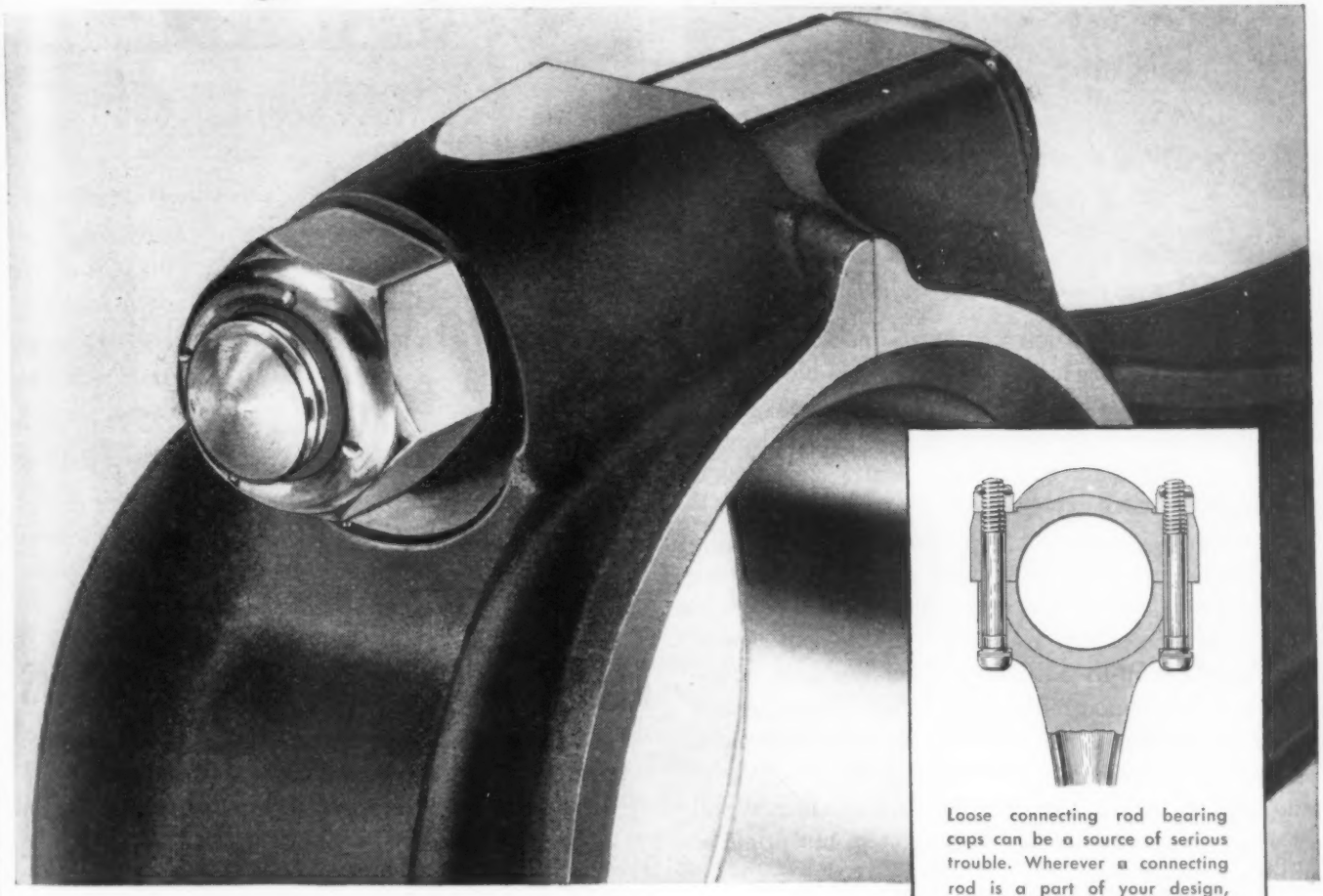
APPLICATION CHART AND SAMPLE KIT . . . Contains swatches of S.A.E. felt types, with specification tables. Write for it. (No sales follow-up.)

2075

Booth
TRADE MARK

PRECISION CUT FELT PARTS

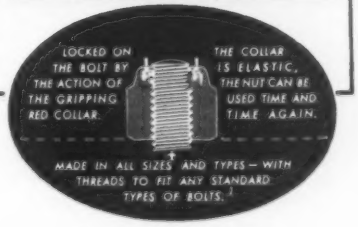
CORRECT *for connecting rods*



Loose connecting rod bearing caps can be a source of serious trouble. Wherever a connecting rod is a part of your design, apply the sure protection of an Elastic Self-Locking Stop Nut. This, or any other nut, won't stop bearing wear or bolt stretch, but it can remedy connecting rod troubles resulting from loose nuts.

Make certain that the bolt extends completely through the collar.

LOCKS FAST TO MAKE THINGS LAST


LOCKED ON THE BOLT BY THE ACTION OF THE GRIPPING RED COLLAR.
THE COLLAR IS ELASTIC, THE NUT CAN BE USED TIME AND TIME AGAIN.
MADE IN ALL SIZES AND TYPES — WITH THREADS TO FIT ANY STANDARD TYPES OF BOLTS.

THIS NUT ALWAYS HOLDS FAST

Under tough operating conditions, on connecting rod bearings for instance, the Elastic Self-Locking Stop Nut does its job, by gripping fast. An ordinary castellated nut or jam nut might break loose, lose its grip and fail, and so would the parts it is assigned to hold together.

But not the Elastic Stop Nut. It uses its head—for, built into the head of this nut is a locking device, an oil-resistant elastic compression collar. This forms itself to the individual bolt thread, grips it tight. The nut won't loosen or back off under the severest vibration, shock or impact.

You need no cotter pins, no lock-washers or other auxiliaries when you use Elastic Stop Nuts. Thus there is no possibility of broken bits of these extras in the crankcase. Nor is there any distortion of or damage to the bolt or the cap. Made to fit any standard bolt or stud, Elastic Stop Nuts can be used over and over again with fully adequate gripping power. You can turn this nut up to the exact torque you need and be sure it will stay there.

Here is definite insurance against loose bearing caps which means greater safety and reliability in use; greater economy in assembly and maintenance.

ESNA
TRADE MARK

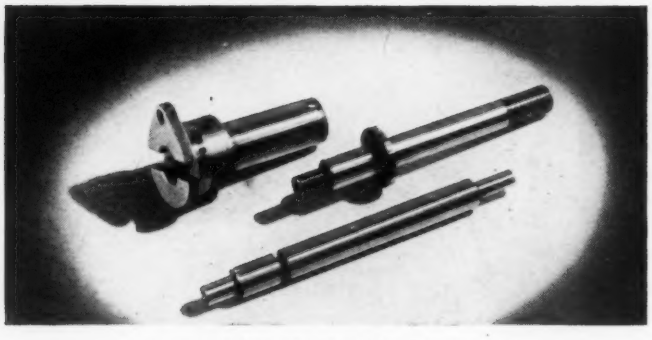
ELASTIC STOP NUT CORPORATION OF AMERICA

Plants at: Union, New Jersey and Lincoln, Nebraska

Sales Office: 1060 Broad St., Newark 2, New Jersey

PRECISION PARTS

FOR THE LONG GRIND AHEAD IT'S EXPERIENCE THAT COUNTS



. . . intricate brazing-jobs made easy

When the last Jap lays down his gun, American industry will begin settling back to competitive production. No longer will it be production for production's sake. The business will go to those manufacturers who have learned a faster, better way of doing things, and who can apply their war-time lessons to the peace-time years ahead.

Grinding-out small parts by the thousands, yet holding to amazingly close tolerances, is an Ace war-time accomplishment that offers real competitive and performance advantages. Here you will find the experienced operators, the up-to-the-minute machines and equipment, and the responsibility of intelligent management to handle your parts from rough stock to finished piece.

If you have any small parts and assemblies calling for stamping, machining, heat-treating, and grinding, it will pay you to consult with Ace. Send sketch, blueprint, or sample for quotations.

GRINDING CAPACITY NOW OPEN

The Idler-Shaft, the Rotor-Shaft, and the Clutch-Bushing shown above are typical of Ace grinding-operations. They involve internal, external, thread, and centerless grinding to .0002" tolerances. Ace makes these parts by the thousands and a modern, well-equipped inspection department assures uniform accuracy of each piece.

ACE

TRADE MARK

ACE MANUFACTURING CORPORATION

for Precision Parts

ARMY E NAVY

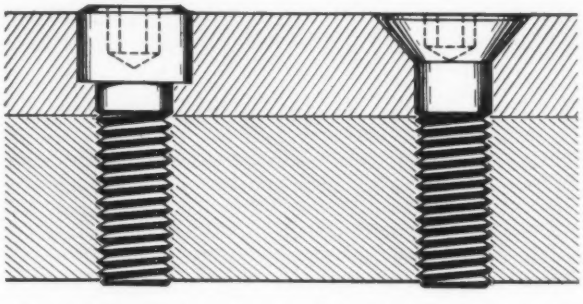
1245 E. ERIE AVE., PHILADELPHIA 24, PA.

V-head design fits counterbored hole with *no gap* between screw head and surrounding metal. This gives frictional grip and a locking rigidity, reinforced by the tightest of set-ups possible only by powerful wrenching with an Allen Hex Key.

The screws are "pressur-formd" of ALLENOY steel, with uncut metal fibres shaped to the head. Threads also are *pressur-formd*, with tolerances held to a high Class 3 fit.

ALLEN FLAT HEAD CAP SCREWS

set up *flush* in holding comparatively thin plates or superposed parts, without weakening the metal with deep countersink.



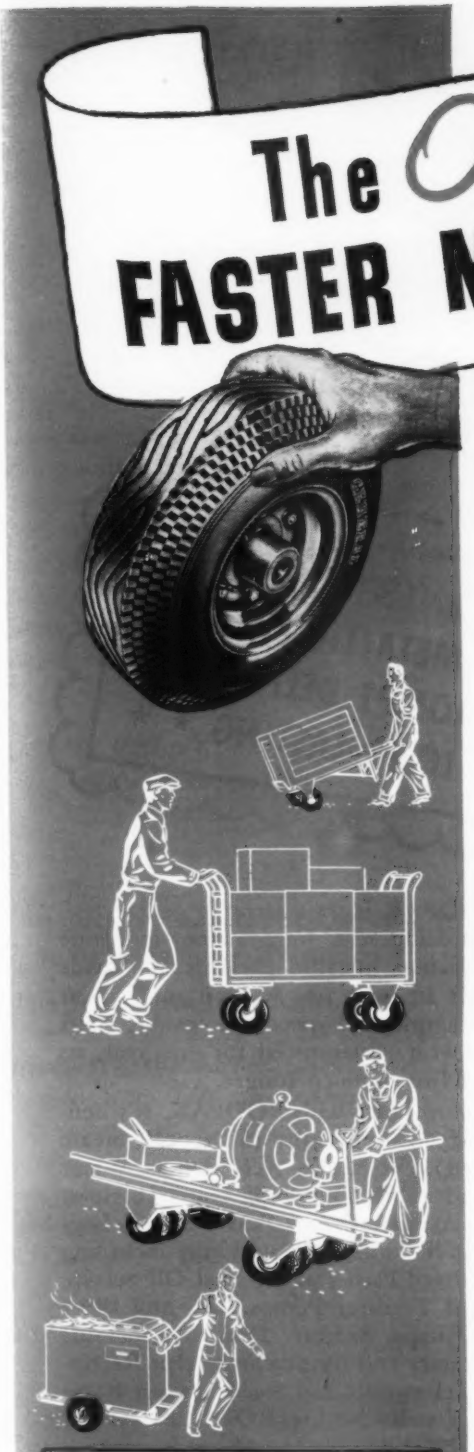
Above diagram shows how flush surface is achieved with shallow countersink as compared with ordinary socket head cap screw. Note more binding surface under the head than is had with a fillister or cheese-head type. The angle helps lock screw in place by drawing down on a conical surface.

Your local Industrial Distributor supplies also Allen Socket Head Cap Screws, Hollow Set Screws, "Tru-Ground" Shoulder Screws and "Tru-Ground" Dowel Pins. Ask him for samples and details.

THE ALLEN MFG. COMPANY

HARTFORD, ★ ALLEN ★ CONN.

The *One* greatest aid to FASTER MATERIAL HANDLING



GENERAL

Industrial Pneumatic

TIRE-TUBE-WHEEL UNITS

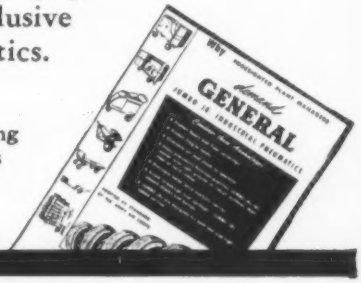
- **Obtainable NOW on many types of NEW material handling equipment.**
- **AVAILABLE in ready-to-install units to modernize present equipment.**

The *one* engineering improvement you will see most widely adopted for *postwar* material handling equipment is the General Industrial Pneumatic Tire-Tube-Wheel. For, General Pneumatics have proved that they ease and speed hauling over rough, soft or smooth surfaces, reduce labor requirements, cut equipment maintenance, and stop cargo spillage and floor wear.

General's are the *original* extra-capacity wide rim tire . . . offer the *only* quick demountable wheel . . . are the *standard* chosen for Army Air Corps industrial applications. On NEW equipment . . . or to modernize OLD equipment . . . be sure you get the exclusive advantages of General Pneumatics.

COMPLETE DATA READY

Full information on applications; engineering and design data for use on new products and modernizing old material handling equipment with Generals.



AVAILABLE NOW
8"—22" o. d. 180 to 1900 lb. capacity per tire.
READY-FOR-USE
Tire-Tube-Wheel Units and Casters.

The GENERAL TIRE

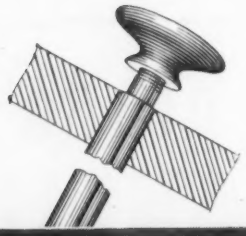
Dept. 6, THE GENERAL TIRE & RUBBER CO., Akron, Ohio

Please send the General Industrial Tire Bulletin to:

Name _____

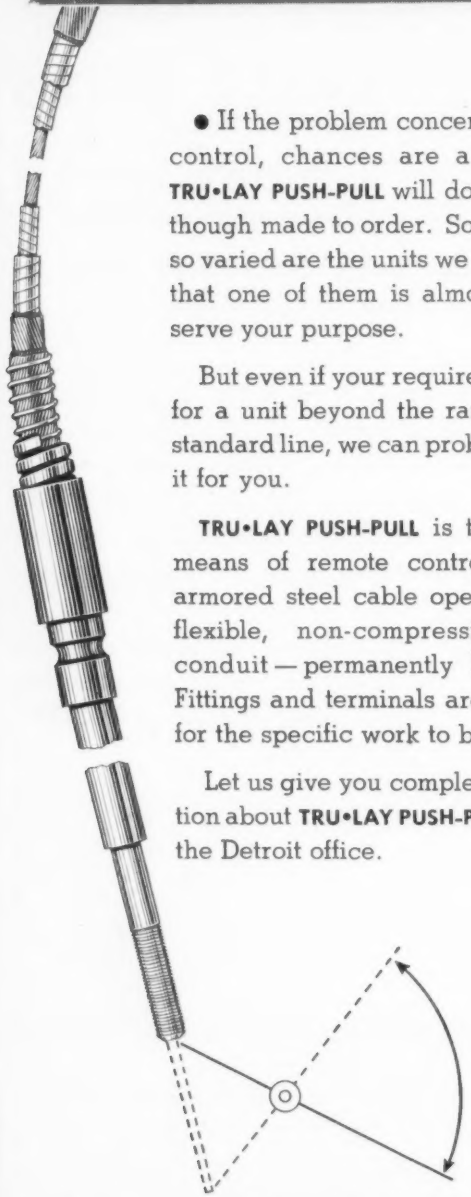
Address _____

Title _____



PUSH-PULL

ONE ANSWER TO A THOUSAND PROBLEMS



● If the problem concerns remote control, chances are a standard **TRU•LAY PUSH-PULL** will do the job as though made to order. So many and so varied are the units we now make that one of them is almost sure to serve your purpose.

But even if your requirement calls for a unit beyond the range of our standard line, we can probably make it for you.

TRU•LAY PUSH-PULL is the simple means of remote control. It's an armored steel cable operating in a flexible, non-compressible steel conduit — permanently lubricated. Fittings and terminals are designed for the specific work to be done.

Let us give you complete information about **TRU•LAY PUSH-PULLS.** Write the Detroit office.

ACCO

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695 Bryant Street, San Francisco 7 • Bridgeport, Conn.

AUTOMOTIVE AND AIRCRAFT DIVISION
AMERICAN CHAIN & CABLE

In Business for Your Safety

RODPAK is the patented, guaranteed, non-friction, floating seal, long-lasting, moderate cost, highly efficient metallic packing. It's made when you want it, how you want it to fit your specifications. Simple and speedy to install; swift to fit, slow to wear. Guaranteed for one year, its average service life is much longer.

Pack up your troubles with RODPAK. It's definitely superior for Compressors (all types), Steam Units (Saturated), Oil Pumps, Acid Pumps, Water Pumps (hot and cold), Hydraulic Units (high or low pressure), Asphalt Pumps, Valve Stems, Logging and Sawmill Units, Marine Units including Main and Auxiliary Feed Pumps, Fuel Oil Service Pumps, Fuel Oil Transfer Pumps, Fire and Bilge Pumps, Brine Pumps, Sanitary Pumps, Generator Engines, both rotary and reciprocating type Refrigeration Units, Telemotors and Steering Gear Rams and many other units having RODS, SHAFTS, LINERS, PLUNGERS. If you want packing promptly, if you want packing that keeps on the job for years . . . **"PACK UP YOUR TROUBLES"**

Specify **RODPAK**
METALLIC PACKING
for rods, shafts, inside & outside packed plungers

RODPAK MANUFACTURING CO.
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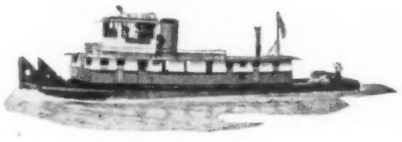
How Engineering has Licked *HEAVY DUTY*

CLUTCH TROUBLES

If you operate heavy machinery, you know that your time losses and your maintenance expense are very likely to come from clutch trouble.

Modern engineering has come to your rescue with the Fawick Airflex Clutch, which controls power and torque by air, without arms, levers, toggles or springs.

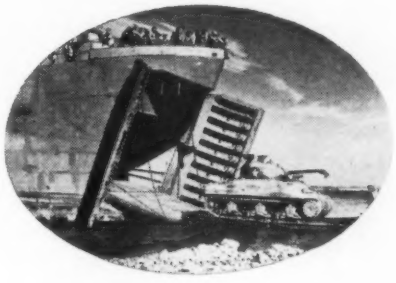


Tug goes from full speed ahead to full reverse in 3 seconds

Here is proof in the toughest kind of service. On this powerful Diesel-driven tug, the Airflex Clutch was thrown from full speed ahead to full reverse in 3 seconds, without damage to engine or propulsion mechanism. No other type of clutch could possibly absorb torque in this manner.

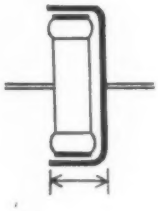
Greater maneuverability for all Naval craft

Hundreds of Diesel-driven vessels in the Navy, Coast Guard and Merchant Marine have been equipped with Airflex Clutches. Without exception, these ships have greater maneuverability. Valuable space is saved, time is saved in installation and maintenance, and in the training of personnel, and performance has new reliability, especially under combat conditions.



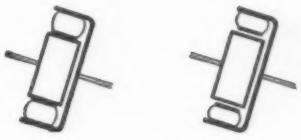
Landing Craft made easier to handle

The landing craft of various types that are so essential in modern warfare are being equipped with Fawick Airflex Clutches to give them more flexibility of operation, and greater dependability under extreme circumstances.



Space-saving is a definite plus

Because the Airflex Clutch has no toggles, levers or springs, it saves, through its compact design, a tremendous amount of space over other types. This is especially important on marine installations, and wherever heavy-duty drives must be put into restricted places, such as cranes, hoists and draglines.



How the Fawick Airflex Clutch Works

Inflate the rubber-and-fabric gland and it expands to engage the clutch. Deflate and the clutch is disengaged. As simple as that is the way the Fawick Airflex Clutch controls power by air, without springs or levers or toggles.

Suitable for many important industrial applications

The Fawick Airflex Clutch has proved its efficiency and economy on steel mills, rubber mills, paper mills, hoists, shovels, cranes, draglines, dredges, presses, punches—all types of heavy duty machinery. Acts as clutch, brake, slip-clutch, flexible coupling or power take-off.

Engineering service

The Fawick Engineering Department will gladly consult with you on clutches for all kinds of heavy duty drives. Booklet on request.

• • •

FAWICK AIRFLEX COMPANY, INC.

9919 Clinton Rd. · Cleveland 11, O.

In Canada, Renold-Coventry Ltd., Montreal, Toronto, Vancouver

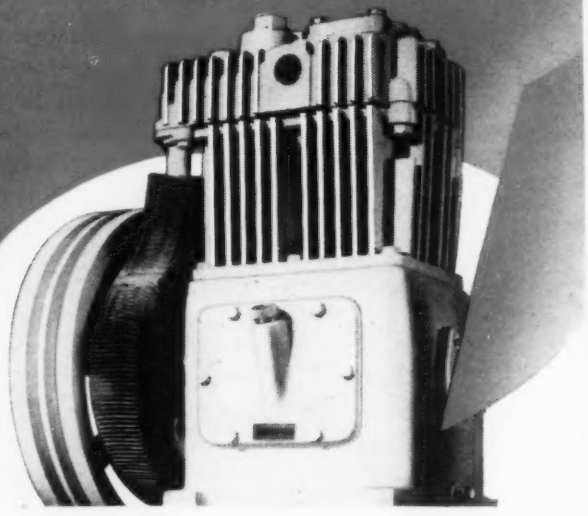
In Britain, Crofts Engineers, Ltd., Bradford, England

FAWICK *Airflex* CLUTCH

POWER CONTROLLED BY AIR

designed for designers

By Air-Power Specialists



extreme compactness—Plus greater over-all efficiency are the result of Quincy's advanced, improved design—both inside and out.

greater efficiency—Quincy Compressors size-for-size offer the maximum over-all efficiency—the most air power production for the lowest power consumption.

"automotive-type" features—Cushioned steel valves for quieter operation; constant level oiling. Timken bearings, semi-steel pistons and Quincy loadless starting which eliminates noisy check valves and minimizes motor burn-outs, are valuable Quincy features.

complete range of sizes—Quincy offers the most complete range of sizes in both air and water cooled compressors up to 80 cu. ft. displacement.

complete dependability—For 24 years all of Quincy's research, engineering and manufacturing facilities have been devoted *exclusively* to producing the most efficient and dependable compressor possible. Nearly 100 leading manufacturers equip their own products with Quincy Compressors.

engineering assistance—Our engineering department is available at all times to help you on problems of both mobile and stationary compressed air supply.

New*—COMPRESSOR SELECTOR—*Free

Accurately selects correct size and type compressor in one minute! One setting gives free air delivery, rpm, piston displacement and hp motor required. FREE on request.

QUINCY COMPRESSOR CO.
QUINCY, ILLINOIS

Quincy COMPRESSORS

Branch Offices: NEW YORK • CHICAGO • SAN FRANCISCO • ST. LOUIS

RITCO

SPECIAL MACHINEWORK TO YOUR BLUEPRINT

RITCO's complete machine shop facilities and modern testing equipment assure quality and accuracy in every part produced. We are well equipped by these facilities and more than a century's experience in metal working to help you with your postwar planning and products. Estimates gladly submitted.

Shown at left: Special monel metal shaft, 2" diam., 20" long, produced for the Warren Steam Pump Company, Inc.

Remember **RITCO** *for*

SPECIAL BOLTS, NUTS AND STUDS
DROP FORGING & DIE SINKING
HEAT TREATING
SPRAYED METAL SERVICE
PARKERIZING
CENTERLESS GRINDING

Catalog on request.

RHODE ISLAND TOOL COMPANY

148 West River St. Providence 1, R. I.

Serving American Industry Since 1834

UP GOES PRODUCTION!
DOWN GOES COST!

WITH HANSEN COUPLINGS

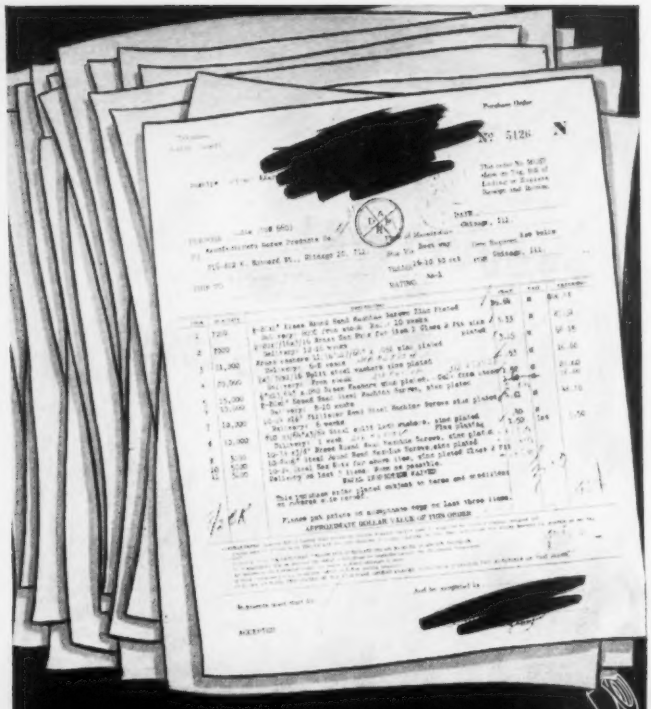
● In tomorrow's market, "costs" will be a big factor, not just a talking point, because competition is going to be two-fisted and short-cuts all along the line of manufacturing in the way of savings will be the smart order of the day. Hansen Push-Tite Air Hose Couplings are triple "savers". They save time . . . save effort . . . save air and with all this saving comes far greater production.

Hansen Push-Tite Couplings are fast, simple and easy to operate, slight push of plug into socket, it's connected, locked and air is automatically turned on. Slide sleeve back with thumb, it is disconnected and air is automatically turned off. Hansen Couplings will take pressures from 2 ounces to over 10,000 pounds without leaking. No twisting or turning in order to lock or unlock, full-swivel action prevents kinking of hose. No pins to bend, break or jam, all parts are fully protected.

Hansen Couplings are made for air, oil, grease, gasoline, acetylene, and oxygen. Send for free industrial catalog covering the complete line of Hansen equipment.

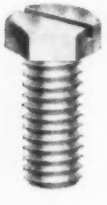
THE HANSEN MFG. COMPANY
1786 EAST 27th STREET
CLEVELAND 14, OHIO

Buy an extra War Bond
AND KEEP IT !!



Thousands of Buyers Depend upon—STRONGHOLD SCREW PRODUCTS

A LIST of the important, BIG users of Stronghold Fasteners reads like the "WHO'S WHO" of American Industry; but in addition there are many hundreds of comparatively small users who also depend upon Stronghold. All of them, big and little, have found Stronghold a DEPENDABLE SOURCE OF SUPPLY—both as to quality of product and quality of service. May we quote on your own requirements?



HEX-SCRO

A SLEEK new multi-use multi-drive Stronghold improvement upon the ordinary machine screw. It has so many mechanical and use advantages that we've prepared a special folder to give you all the facts about it. May we send you a copy?—and samples?

MANUFACTURERS SCREW PRODUCTS
210 W. Hubbard St. Chicago 10, Ill.
***It's Faster to Telephone* • Call WHITEHALL 4680**

If You Must Be Dead-Sure You Have the Right Spring—See RELIABLE

With the gradual expansion in production of all kinds of mechanical goods, for normal civilian uses, there will arise *new* needs for precision parts. If, in re-designing *your* products, your spring requirements are more exacting than ever before—look to RELIABLE for such service. Springs are an extremely small item of cost—but on their accurate performance may depend the service record of *your* equipment. Therefore the *best* spring is the *only* spring for a quality product. With expert engineering, and with a high degree of precision in manufacture, RELIABLE has met many difficult problems covering an almost endless range of specifications. In every department of spring production, our facilities are exceptional.

Remember, too, that on wire forms and small steel stampings, RELIABLE will give you the kind of *personal* cooperation that saves time, trouble and costs. Be sure your springs are *Reliable*.

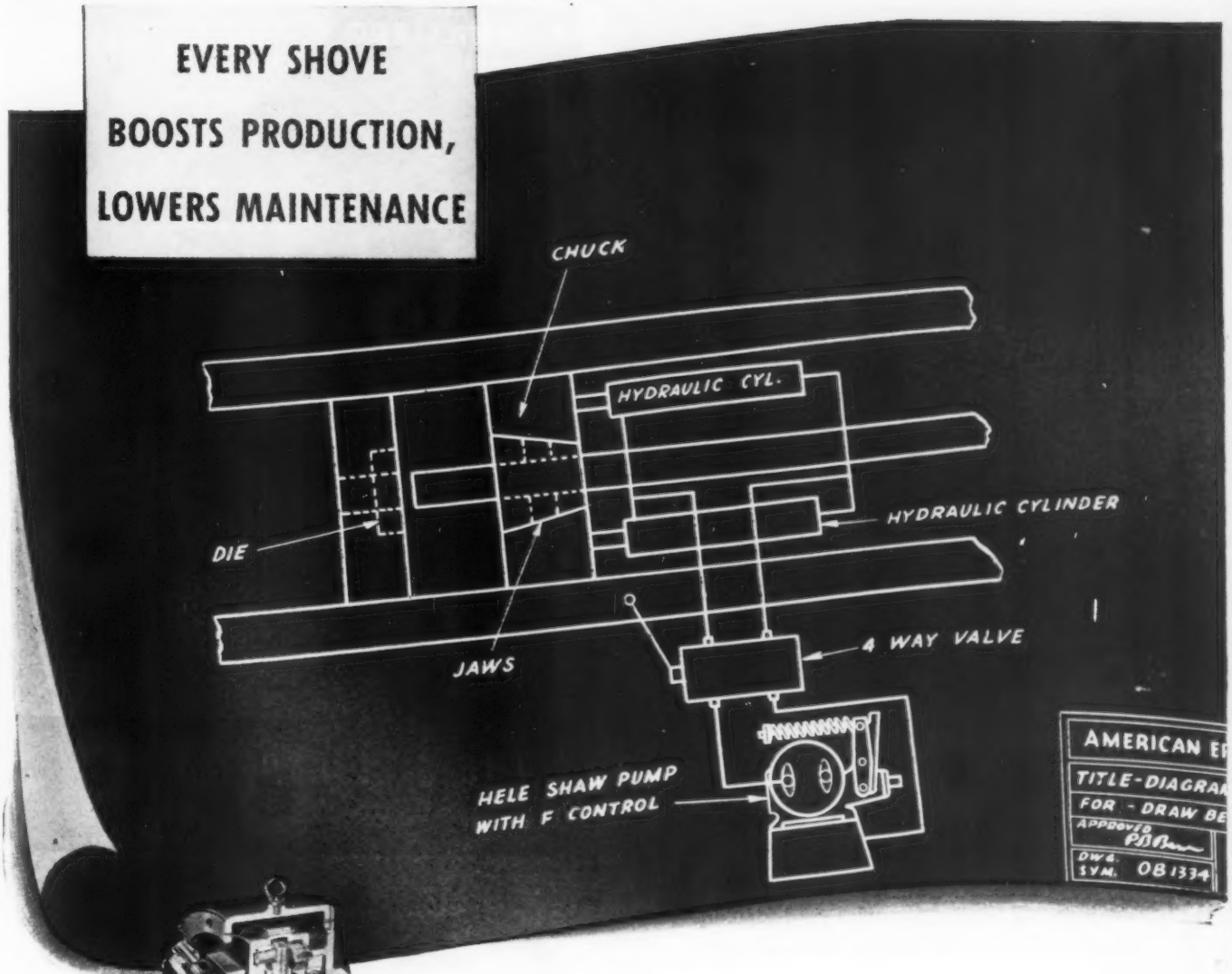
Catalog 44 sent on request.

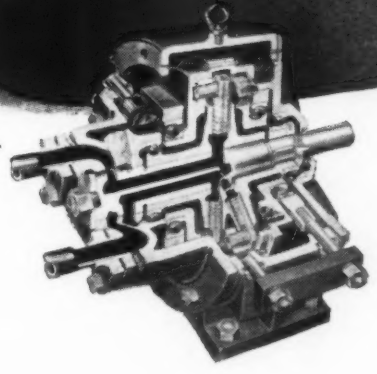
THE RELIABLE SPRING & WIRE FORMS CO.
3167 Fulton Rd. Cleveland 9, Ohio

Representatives in Principal Cities

YOU CAN RELY ON
Reliable Springs
ROUND AND FLAT WIRE SPRINGS
CLIPS HOOKS BENDS LIGHT STAMPINGS

EVERY SHOVE BOOSTS PRODUCTION, LOWERS MAINTENANCE





THE HELE-SHAW

Fluid Power

PUMP

OTHER Æ PRODUCTS:
Æ-TAYLOR AND PERFECT SPREAD STOKERS,
MARINE DECK AUXILIARIES, LO-HED HOISTS
DIAMOND FACE GRINDERS

Hele-Shaw Fluid Power Furnishes Big Push on Draw Bench

Maintenance on the old draw bench got to be a headache. Wear and tear on the old worm gear and lead screw arrangement for pushing the bar through the die up to the puller was way overboard.

Casting about for a better method, the user hit upon Hele-Shaw Fluid Power (oil under pressure) . . . asked us to help out. With him, our engineers worked out a hydraulic device which not only filled the bill but saved maintenance, saved time and simplified operation. Now a pull of one small lever and the chuck rides up into position pushing the bar through the die. Another push and the jaw chuck returns.

Hele-Shaw Fluid Power is a means toward better, faster, smoother and safer operation in an amazing variety of hydraulic operations. Go hydraulic with the Hele-Shaw Pump and let Hele-Shaw engineers help you work out your application.

AMERICAN ENGINEERING COMPANY

2414 ARAMINGO AVENUE, PHILADELPHIA 25, PA.

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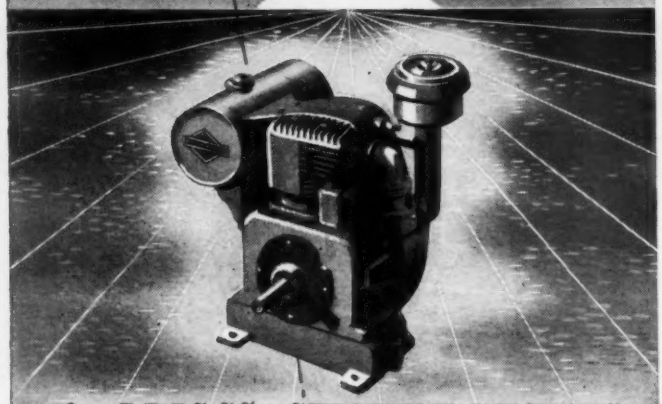
NEW FRONTIERS



for BRIGGS & STRATTON ENGINES

During more than a quarter-century of *continuous* production of *"air-cooled power,"* Briggs & Stratton has been constantly recognized as the leaders in this field — and has earned foremost recognition for pioneering in improved design — for engineering advancements — and for constantly improved precision manufacture.

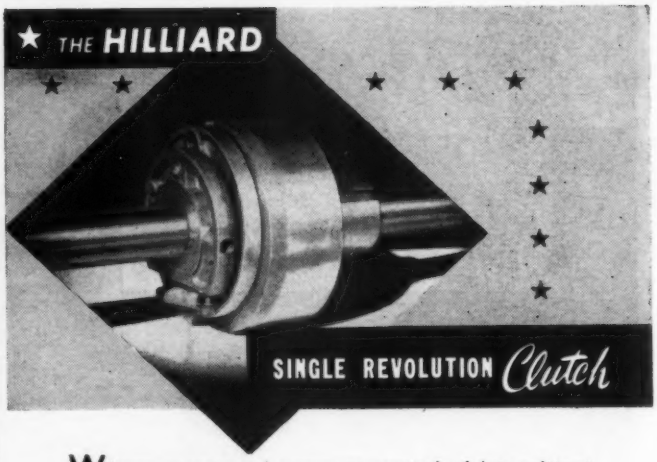
Their unequalled performance has again been proven by the brilliant record of Briggs & Stratton 4-cycle *air-cooled* gasoline engines in hundreds of standard and special wartime uses and applications. Their dependable service under severest conditions assures still greater service in the period ahead — through use on an ever increasing number of gasoline-powered appliances and equipment.

Air-Cooled Power — 4 CYCLE BRIGGS & STRATTON GASOLINE ENGINES

Only in Briggs & Stratton 4-cycle air-cooled gasoline engines can you get the extra performance made possible *through 25 years of consistent leadership.* Let us help you plan in fitting this dependable power into your designing and production of gasoline powered equipment, tools, and appliances.

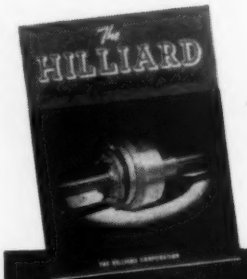
BRIGGS & STRATTON CORPORATION
Milwaukee 1, Wisconsin, U S A.

★ THE HILLIARD



SINGLE REVOLUTION *Clutch*

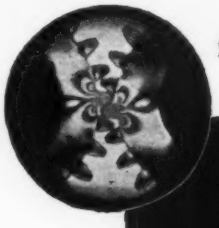
Wherever extremely accurate control of intermittent machine operation is essential the Hilliard Single Revolution Clutch is unequalled. Its accuracy has won for it the acceptance of Industry for cutting, punching and packaging operations.



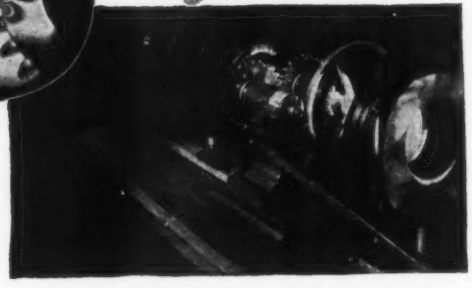
★ **WRITE TO-DAY!**

For the new series of 6 illustrated Bulletins furnished FREE upon request. Featuring our complete line of Industrial Clutches and Couplings – Over-Running – Single Revolution – Friction – Centrifugal – Overload Release – Slip.

★ THE HILLIARD *Corporation* ★
101 WEST 4TH ST. ELMIRA, N. Y.
CENTRIFUGAL SLIP OVER-RUNNING FRICTION OVERLOAD RELEASE



studying *Strains...*



...with plastic models

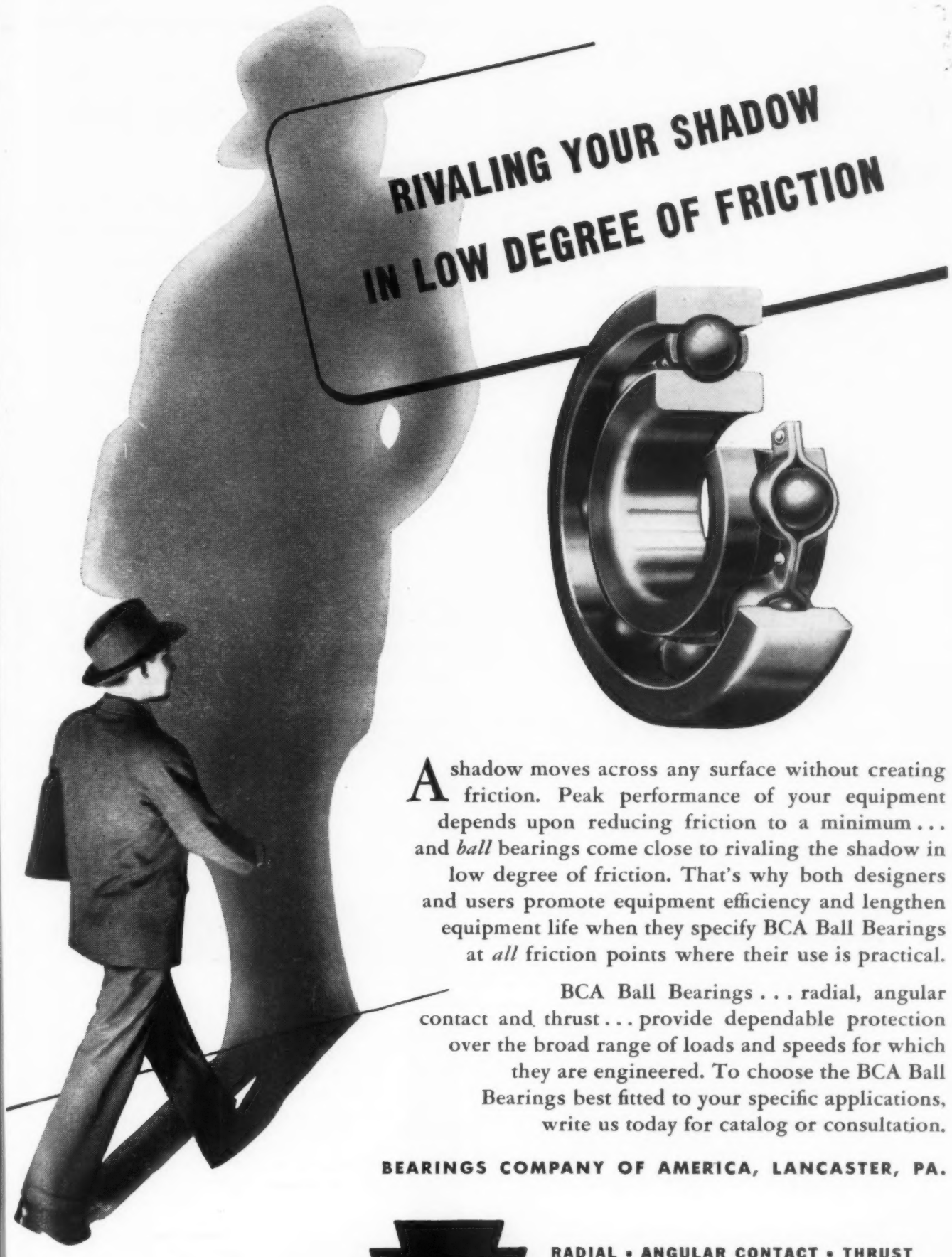
Of interest to engineers is our method of observing actual stresses in meshing gear teeth. Photoelastic equipment is used, in these tests, to check visually on mathematical calculations of stresses and strains. A polarized light is passed through transparent gear models and the image on the screen shows in color the lines of stress which develop in the meshing teeth.

Fairfield's ability to build fine gears is backed by 25 years of experience. With an eye to the future, investigate Fairfield facilities for gear making. Write for our brochure on gears.

ARMY E NAVY

FAIRFIELD MANUFACTURING CO.
313 S. Earl Avenue • Lafayette, Ind.

FAIRFIELD *For* FINE GEARS



RIVALING YOUR SHADOW IN LOW DEGREE OF FRICTION

A shadow moves across any surface without creating friction. Peak performance of your equipment depends upon reducing friction to a minimum . . . and *ball* bearings come close to rivaling the shadow in low degree of friction. That's why both designers and users promote equipment efficiency and lengthen equipment life when they specify BCA Ball Bearings at *all* friction points where their use is practical.

BCA Ball Bearings . . . radial, angular contact and thrust . . . provide dependable protection over the broad range of loads and speeds for which they are engineered. To choose the BCA Ball Bearings best fitted to your specific applications, write us today for catalog or consultation.

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BALL BEARINGS

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OUR NEW CATALOG "E"

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VALVES AND FITTINGS SINCE 1904

Still ★ ★ ★ on the job

Production of gears for our Armed Forces will not cease until Victory over Japan.

In the meantime, Diefendorf engineers will gladly help with your gearing problems for post-war products.

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Syracuse 1, New York

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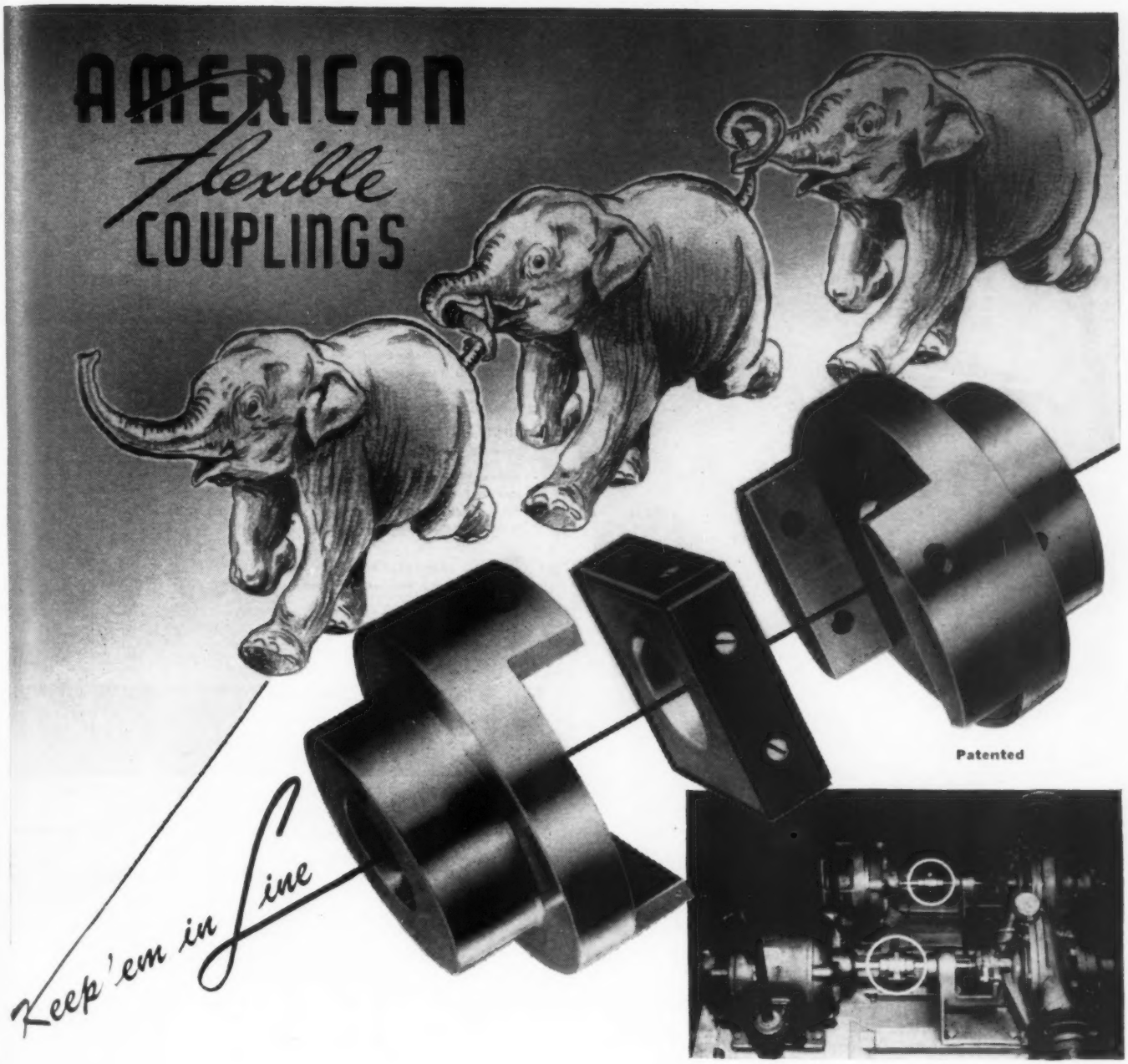
BURGESS THINSTRIP MAGNESIUM
AS THIN AS .005" IN COILED-STRIP FORM

THIS NEW DEVELOPMENT is now available for production applications from Burgess rolling mill facilities. It can be supplied in widths from ¾" to 5" and from .010" to as thin as .005".

COMPLETE INFORMATION—technical specifications, cost figures, sample strip, and the answer to your problem—is available free in new folio.

Sample on request. Write Dept. M-3
BURGESS BATTERY COMPANY
FREEPORT, ILLINOIS

AMERICAN *Flexible* COUPLINGS



Patented

Keep 'em in Line

A typical installation in a heat treating department of a large manufacturer of war material.

CORRECT alignment is vital to the efficient transmission of power... American Flexible Couplings are meeting all power transmission requirements efficiently . . . It's easy to see why. 3 sturdy parts only. Two identical flanges connected by a square floating center member, a centrifugal lubrication unit of high strength alloyed metals . . . The American is the only flexible coupling with replaceable bearing strips, eliminating the need of tearing down the unit . . . the reason why power men "in the know" prefer American Flexible Couplings. For full particulars on American Flexible Coupling application for light, medium and heavy duty work, write for complete catalog.

Ordnance Division

ZURN

AMERICAN FLEXIBLE COUPLING CO.
DIVISION OF
J. A. ZURN MFG. CO., ERIE, PENNA.

★METAL STAMPINGS

METAL stampings in any quantity from steel, brass, copper, aluminum, aluminum alloys and other metals up to 10 gauge. Short special runs produced economically, and batteries of automatic presses stand ready to meet production schedules on large runs.

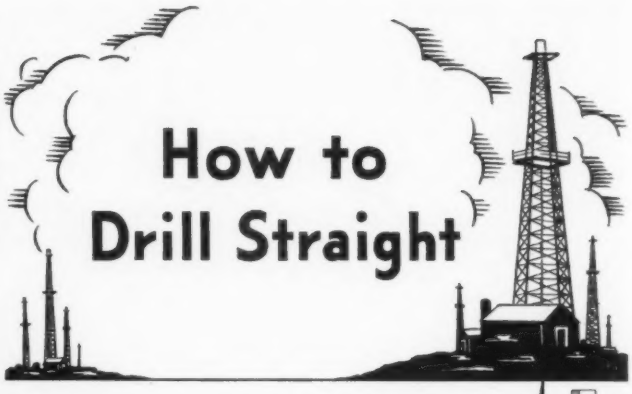
Titchener also makes combination stamping-and-wire assemblies, and is equipped for electric welding operations, enameling and plating.

A tool engineering staff is maintained for manufacturing consultation; and the services of our toolroom are available. 59 years of experience is your guarantee that a Titchener job will be RIGHT. Send samples or prints of your requirements for quotation.

Aluminum has many definite physical properties which make it more desirable for certain products than any other metal. Due to its resistance to the corrosive action of the atmosphere and to many chemicals, most aluminum stampings require only a "tool finish." Here, tool design and operation become a factor in economy, and here Titchener skill and experience is evidenced by the cleanly-cut edges, surface-smoothness and symmetry of the formed product.

E. H. TITCHENER & CO.
Strip Metal and Wire Forming
350 WALNUT ST. BINGHAMTON, N. Y.

How to Drill Straight

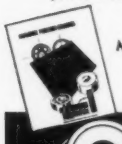


The E-C Inclinometer shown here, made by Sperry-Sun Well Surveying Co., records automatically, the deviation from intended course, in drilling oil wells. It travels 800 to 1000 feet per minute in the drill pipe; is the fastest recording instrument of its type.

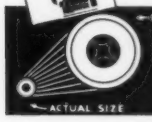
MPB is proud to contribute to the sensitivity, accuracy and durability of this instrument with MPB Pivot Ball Bearings.

Some of the mechanisms you make may need Miniature Precision Ball Bearings to make them free-moving yet precise, strong and compact. Let MPB engineers work with you. No obligations. Write for MPB bearings specifications. P. E. 7-45

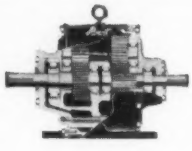
World's smallest ball bearings: radial, 1/8" to 5/16"; pivot, 2 to 10 mm., outside diameter.



MINIMIZE* WITH MINIATURE
* weight, space, friction

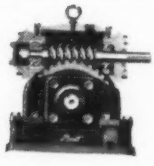


MINIATURE *Precision* BEARINGS
KEENE, NEW HAMPSHIRE, U·S·A·



Type CA Straight line Spur Gear Reducer. Ratios up to 20 to 1. Sizes up to 417 h.p. Ask for Bulletin 1200.

"I choose the 1945 Reducers!"



Type A, Worm Gear Reducer Ratios 4 5/6 to 1, up to 100 to 1. 1/2 to 98 h.p. Ask for Bulletin 900.

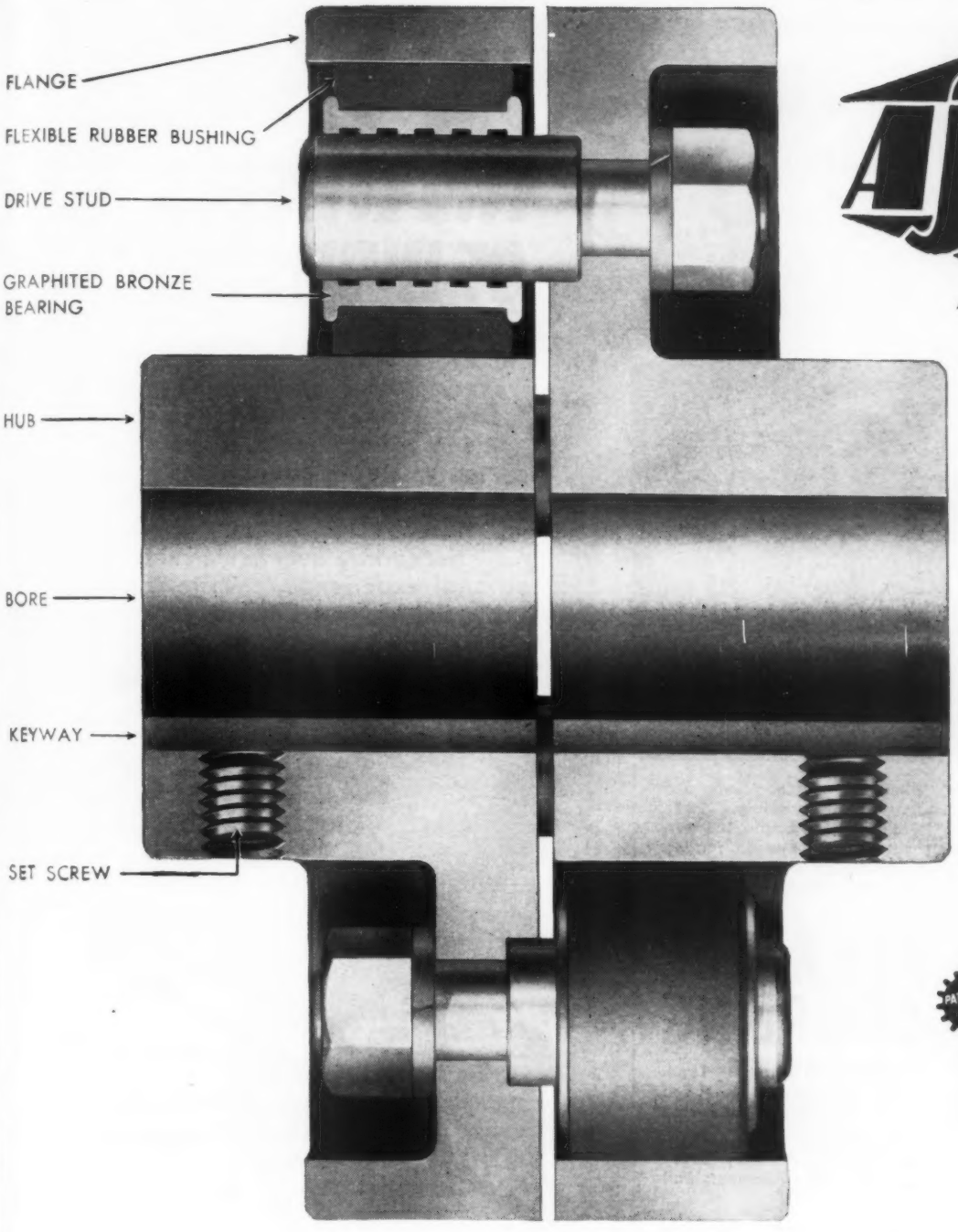
Since Speed Reducers superseded the old clumsy open methods of reduction ((prey to grit, dust, rust, and inaccuracy) there has been equally great improvement in reducer efficiency. It pays to know the advances that have been made, and intelligently to select the most modern.

Abart SPEED REDUCERS

Abart Reducers embody the very latest in design and sturdy construction. Compact—enclosed—oil-tight—dust-proof. Rigidly supported bearings—perfect alignment. More than 75 sizes and types to choose from. Spur, worm and combinations. 1/50 to 417 h.p.

ABART GEARS: No stocks. Send B/P for estimates.

Abart GEAR AND MACHINE CO.
MANUFACTURERS OF
Speed Reducers & Gears
4840 WEST 16TH ST., CHICAGO 50, ILLINOIS



AJAX

Incorporated 1920

PATENTS MAKE JOBS

THE INSIDE STORY OF AJAX FLEXIBLE COUPLINGS

Ajax Flexible Couplings protect direct connected machines from unavoidable misalignment. They require no lubrication. They are quiet running — no backlash, no noise. They provide free end-float which permits electric machinery to find its magnetic center. They operate satisfactorily in abrasive-laden air.

They are built in a wide range of sizes and capacities with standard couplings *made of forged steel or cast semi-steel.*

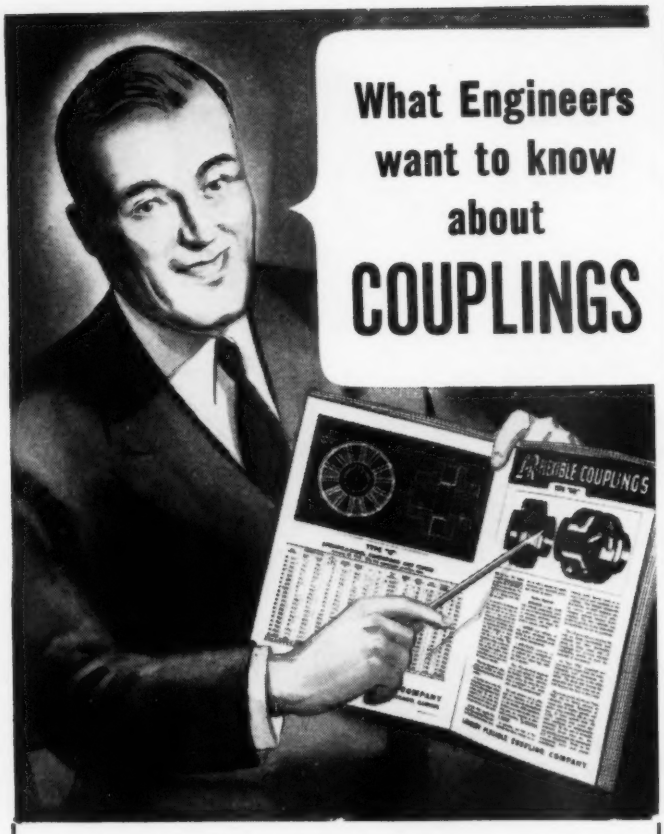
For special requirements flanges can be machined from aluminum, bronze or other metals, and can be plated with chrome, silver or cadmium for protection against adverse atmospheric conditions. Thousands of cadmium-plated Ajax Couplings are running on U. S. Navy equipment throughout the world.

Ajax Couplings can easily be made integral with brake drums, pulleys, fly wheels, etc.

Write for new catalog giving complete data.

AJAX FLEXIBLE COUPLING CO. INC.

WESTFIELD, N. Y.

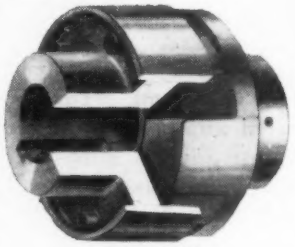


Correction for misalignment, takeup of surge, shock and vibration, etc., are basic functions of the coupling. These are most efficiently insured by the L-R principle of free-floating resilient load cushions suspended between rugged metal jaws. Cushion material is an equally important factor. Correct material is provided for each individual duty, of L-R Couplings. (See below)

L-R FLEXIBLE COUPLING

Resilient Alignment Type. Non-Lubricated. Supplied with cushions in following materials:

1. **METALFLEX:** High-grade brake-lining, for heavy shock loads, as on excavating, and steel mill equipment, and where exposed to weather.
2. **LEATHER:** Best quality oak-tanned belting. For sustained loads, and greater misalignment.
3. **MULTIFLEX:** Rubber-duck fabric, vulcanized under pressure. For fluctuating loads and requirement of high resilience.
4. **ARMORED RUBBER "SX":** For any speed, and fluctuation. Carrying capacity under uniform load less than leather, but "SX" withstands heavier shock loads. Hysteresis loss far less than leather.

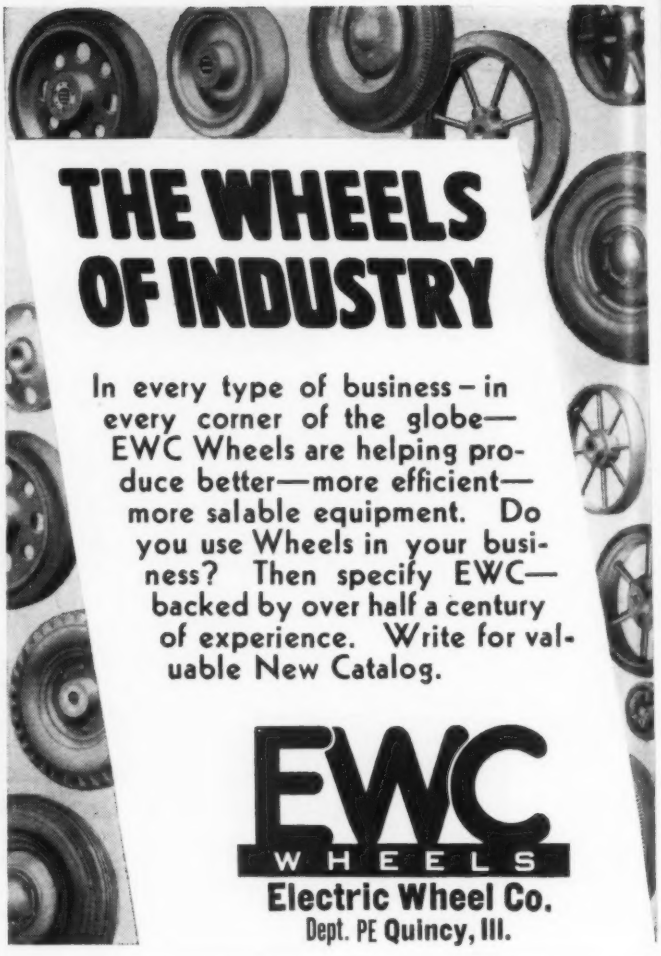


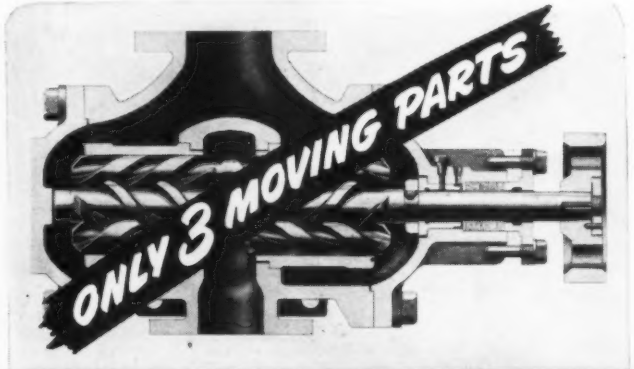
L-R Type "H"
Pat. and Pats. Pend.

Catalog gives full details
Selector Charts find your couplings.

Catalog shows L-R Couplings Extremely quiet for every duty and every kind of service from 1/6 to 2500 h.p. Selector Charts put your finger on couplings you require without tedious figuring. Should be in every engineer's file. Wire or write.

LOVEJOY FLEXIBLE COUPLING CO.
5019 W. LAKE ST. CHICAGO 44, ILLINOIS


THE WHEELS OF INDUSTRY
In every type of business – in every corner of the globe—EWC Wheels are helping produce better—more efficient—more salable equipment. Do you use Wheels in your business? Then specify EWC—backed by over half a century of experience. Write for valuable New Catalog.
EWC
WHEELS
Electric Wheel Co.
Dept. PE Quincy, Ill.



Remember IMO forget TROUBLE

The IMO PUMP has only three moving parts and no valves, timing gears, cams, or delicate adjustments to get out of order. It can be depended upon for hydraulic service, governor service, lubrication service and other applications in which continuity of operation is vital.

For further information write for Catalog I - 126-G

IMO
PUMP DIVISION OF THE
DE LAVAL STEAM TURBINE CO.
TRENTON 2, NEW JERSEY

IS IT LATER THAN YOU THINK?

Oiljak, like other American manufacturers, continues to devote all its facilities to the production of war material, to speed the approaching day of victory.

Yet, at the same time, we consider it no less our duty to plan for the future, to do our part in easing the change-over to a healthy industrial economy during the competitive peacetime years that lie ahead of American industry.

Oiljak offers you complete manufacturing facilities with up-to-date machines operated by men whose production record on war contracts compares favorably with normal peacetime costs; a record achieved by a minimum of rejections, a steady streamlined flow of work and materials through the plant, and a special assembly-line technique for which Oiljak is famous.

So before you set up the manufacturing procedure for *your* peacetime products, it may well be worth your while to get acquainted with all the facilities which Oiljak can offer you.

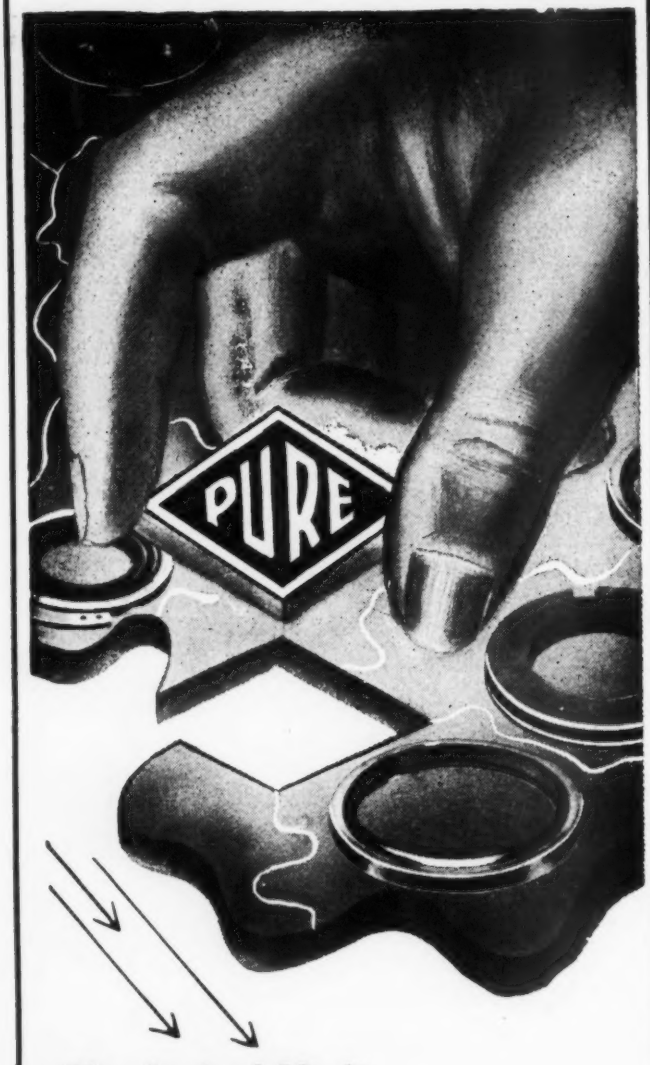
MACHINING · STAMPING · WELDING · PLATING · FINISHING · ASSEMBLING

METAL MANUFACTURERS

THE OILJAK MANUFACTURING Co., INC.

MONTCLAIR, NEW JERSEY

THE JOB COMPLETE FROM BLUEPRINT TO FINISHED PRODUCT



The Seal of Merit Symbolizes the Solution to your Sealing Problems

Seal rings developed by Pure Carbon are meeting the most exacting demands for efficiency. In applications where low friction, non-abrasive and long-lasting seal rings are a necessity, our carbon seal rings are demonstrating their superiority to the complete satisfaction of increasingly more manufacturers. Consult the Pure Carbon engineer in or near your city. He'll gladly co-operate with you in working out the answer to your selling needs.

SEND FOR NEW BOOK DEFINING USES OF CARBON SEAL RINGS

PURE

Pure Carbon Co., Inc.
2102 Nobrac Street
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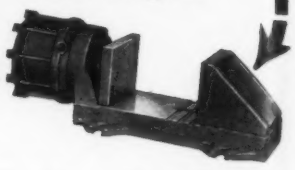
Save Operator Time and Fatigue . . . Obtain Greater Accuracy . . . Increase Production . . . with



"LOGAN" STANDARD AIR VISES

Air-operated production vises can help you increase output, improve accuracy and reduce costs in a wide range of machining and assembling operations.

Logan Air Vises are quick-acting and precise in operation . . . exert a positive pressure with follow-up that prevents spoilage and accidents. Depending on the type, the gripping force is from 285 to 2261 lbs. jaw pressure at 80 lbs. line pressure. They can be controlled by a convenient hand or foot valve, or remotely by push button, electric solenoid, toggle pin or cam.

Workpieces of almost any regular or irregular shape can be held securely in plain or formed false jaw blocks. Logan Air Vises are available in adjustable and stationary master jaw types, and in jaw capacities from 1½" to 7".

SPECIAL AIR-OPERATED FIXTURES

Logan also designs and builds air-operated fixtures and work holding devices to fit your requirements. Send work details . . . ask for engineering recommendations. No obligation.

Logan SAVES ★TIME ★EFFORT ★MOTION

Air and Hydraulic Equipment

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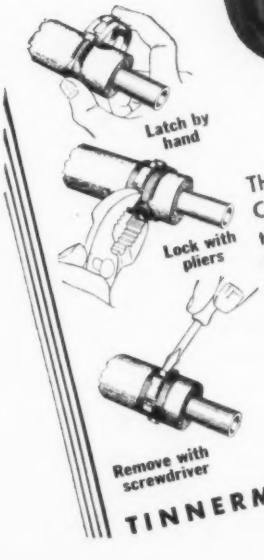
CHUCKS • CYLINDERS • VALVES • PRESSES • BORE-FLOW COOLANT PUMPS

FREE catalogs—Write for literature covering items in the Logan line in which you are interested.

THE *New* TINNERMAN HOSE CLAMP



This one-piece, ratchet type Hose Clamp is easily latched by hand, then quickly locked with pliers. Removed by prying locking tongue out of ratchet teeth with screwdriver. It weighs less, has a lower profile, exerts uniform pressure, and may be used over and over again. Approved by Army and Navy Air Forces. Sizes from ½" O.D. up. Write for details.

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Like the
CHIPPENDALE
HALLMARK
On
Fine Furniture

KOVEN

Has Been the HALLMARK *of* SUPERIOR

INDIVIDUALIZED EQUIPMENT PARTS

Since 1881

Chippendale and KOVEN . . . two names that represent the finest workmanship in their particular field. Since 1881, KOVEN has been designing and manufacturing equipment made to the exact needs of leading manufacturers. These manufacturers have found they can depend upon KOVEN to build a part or parts of their finished product . . . faster and with greater efficiency and economy than they could be made within their own plant.

If you are having production difficulties . . . a trained KOVEN representative will be glad to assist you. Naturally, you will not be obligated in any way. Just call or write to KOVEN. Illustrated—solvent recovery still, completely welded herculoy separator, filter and ink cooling tank made for manufacturers of chemical equipment, presses, gasoline equipment and printing presses.

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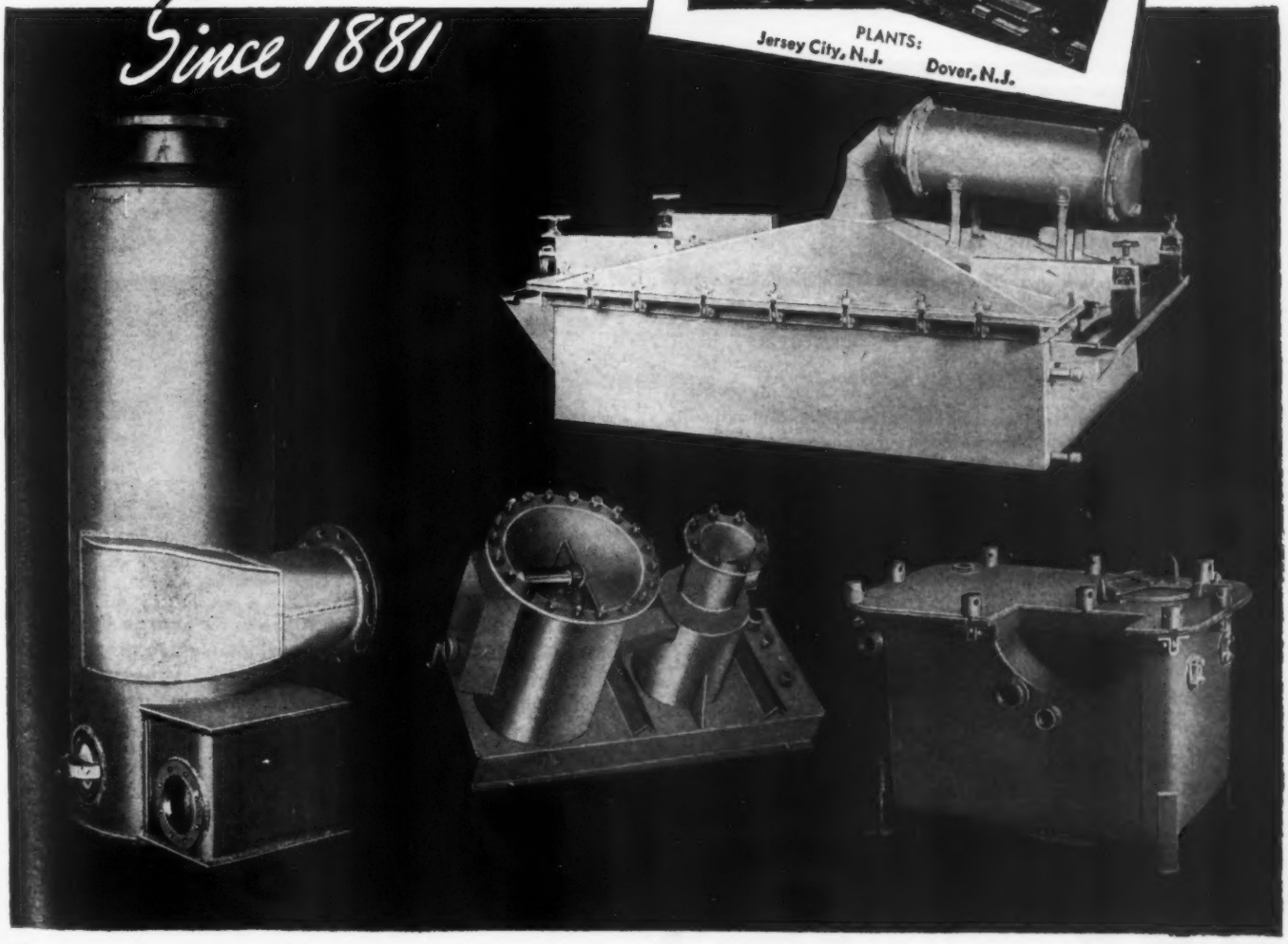
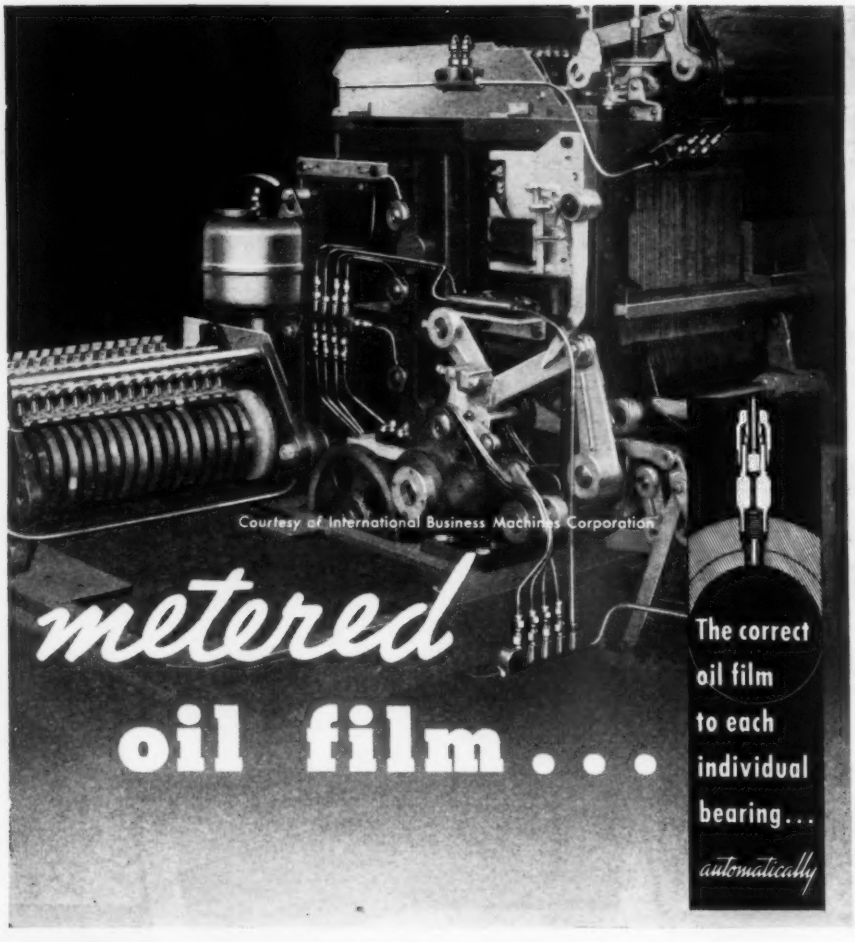
PLANTS:
Jersey City, N.J. Dover, N.J.




Courtesy of International Business Machines Corporation
metered
oil film . . .
The correct oil film to each individual bearing . . . automatically

● Machines remain efficient . . . stand up . . . only when properly lubricated. With the Bijur Automatic Lubricating System, each bearing is served by its own meter-unit. The lubricator pump measures a predetermined quantity of oil feed to the distribution system; the meter-units apportion the feed to the individual need of each bearing—no matter what its size, speed, load. Unfailingly . . . automatically. No lubrication problems, worries, profit-eating expense!

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BIJUR

AUTOMATICALLY *Correct* LUBRICATION

1019

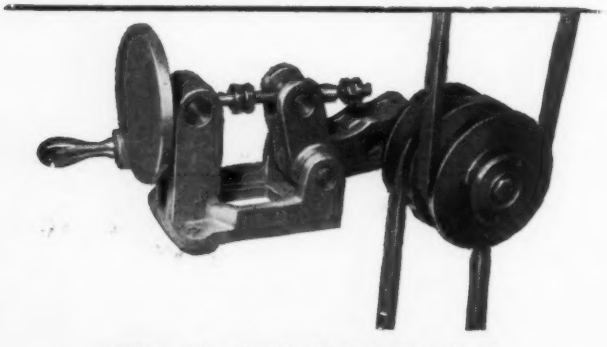
SPEEDMASTER

STEPS UP PRODUCTION

Are your machines set too slow a speed to meet today's production demands? Investigate the Speedmaster, the mode of Variable Speed Control that provides a versatile range of speeds, 6 to 1 ratio.

A turn of the hand wheel changes speeds instantly without work stoppage. Free floating pulley aligns belts automatically and insures long belt life, 3 sizes, 9 different types.

Consult our Engineering Dept. today about adapting Speedmasters to your machines. Ask for interesting new Speedmaster circular.



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ACCURACY—

Provides Good Pump Performance

Pump with flange mounting, dual discharge connections and other special features.

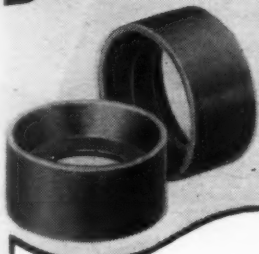
B·S

The outstanding service that Brown & Sharpe Pumps give can be attributed in no small measure to precision manufacture. This manufacture provides the faithful following of sound designs and accurately fitted parts. Catalog sent on request. Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

GEARED — VANE — CENTRIFUGAL — MOTOR DRIVEN

BROWN & SHARPE PUMPS

Let GATKE help you meet difficult Bearing Requirements

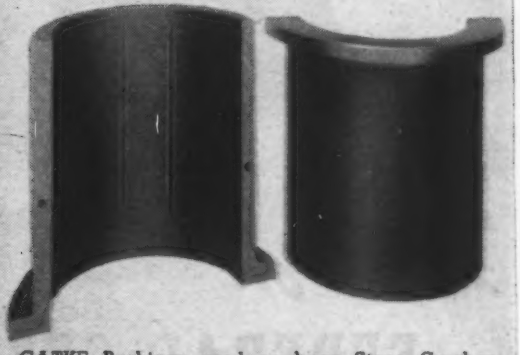


Wearing member of a shock-absorbing device — 7" O.D. Ease of lubrication, non-scoring, non-corrosive qualities and light weight are important advantages.

GATKE Bushing with integrally moulded flange 10" I.D.

GATKE Slipper Bearings used in Universal Couplings of Rolling Mill drives. They withstand terrific shocks and slow rubbing under tremendous pressure—last ten times longer than bronze—eliminate rapid wear and scoring of companion surfaces.

21" Pinion Shaft Bearing for Upsetting Machine.



GATKE Bushings used on huge Stone Crusher. Limited movement and constantly shifting excessive pressures caused galling, scoring and ruinous wear with metal bearings. GATKE Bearings give excellent results. Bearings illustrated are 17⅞" I.D., 24⅛" long.

Only GATKE Bearings Have All These Qualities

Tremendous Wear Resistance

Lowest Friction

Non-scoring — Non-corrosive

Resilience—

(a) to absorb excessive shock loads without taking a permanent set.

(b) to yield under excessive localized pressures, thereby distributing load and avoiding damage to shaft.

(c) to dampen sound and vibration.

Operate successfully at loads and speeds where metal bearings cannot be adequately lubricated.

Weigh 80 to 85% less than metal bearings.

Engineered for the application and made of correct material combinations to meet service requirements.

Precision molded of tough fabrics and special resin compounds under heat and tremendous pressure to required shape and size.

Made in three general types—

LUBRITEX for oil or grease lubrication.

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GRAFITEX for some self-lubricated applications.

On a tremendous range of difficult applications GATKE Bearings give results that render obsolete all previous yardsticks.

Experience with other bearings, however satisfactory, forms no basis for estimating the benefits these wonder bearings offer—only GATKE has the necessary experience and understanding of the many unusual qualities to do that.

Whatever the service, however difficult or unusual, send details for the GATKE Recommendation or write for literature.

GATKE CORPORATION 250 N. La Salle St., Chicago 1.

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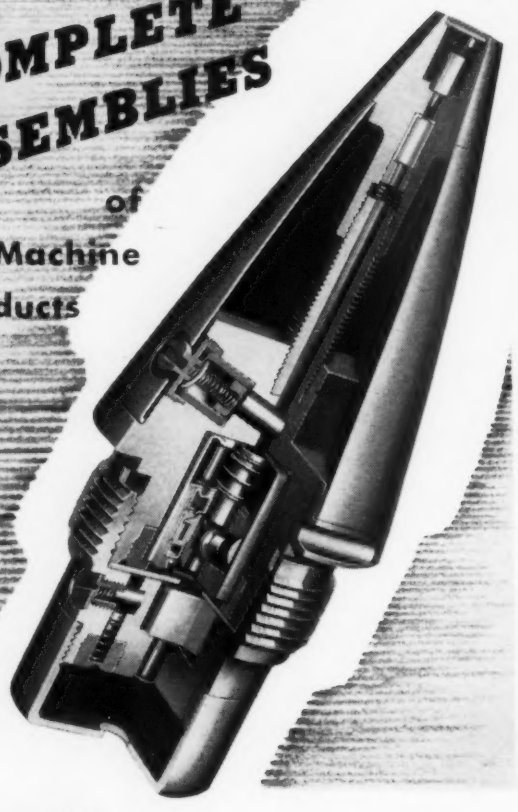
For **COMPLETE ASSEMBLIES** of **Screw Machine Products**



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FEDERAL SCREW

THIS shell fuze is an extremely complicated mechanism demanding close-tolerance work throughout. Millions of these assembled fuzes have been produced *complete* at Federal Screw Works, with only the springs and stampings obtained from outside sources.

We can now do the same sort of work for *you*—producing COMPLETE ASSEMBLIES of screw machine products and cold-forged parts to your exact specifications. Without obligation on your part, we'll be glad to quote on your requirements.

Free illustrated book, "Focus on Federal Screw," gives a quick picture of our manufacturing facilities and many typical products. Write for a copy—on company letterhead, please.

ARMY NAVY

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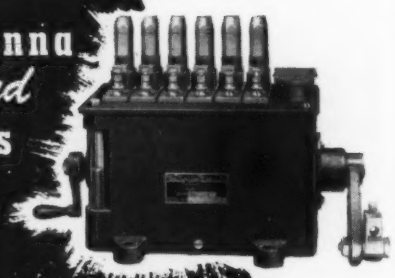
Federal SCREW WORKS

DETROIT AND CHELSEA, MICHIGAN

MAIN OFFICES: 3401 Martin Ave., Detroit 10, Michigan

Hills-McCanna *force-feed* Lubricators



Leaders for Over 65 Years!

Latest model Hills-McCanna lubricators offer internal ratchet drive, single plunger pump principle, positive drip sight feed, highest quality materials and precision workmanship. Available 2 pint to 32 pint reservoir capacity; 1 to 24 feeds. Compact . . . rugged . . . dependable. For data and prices, write today.

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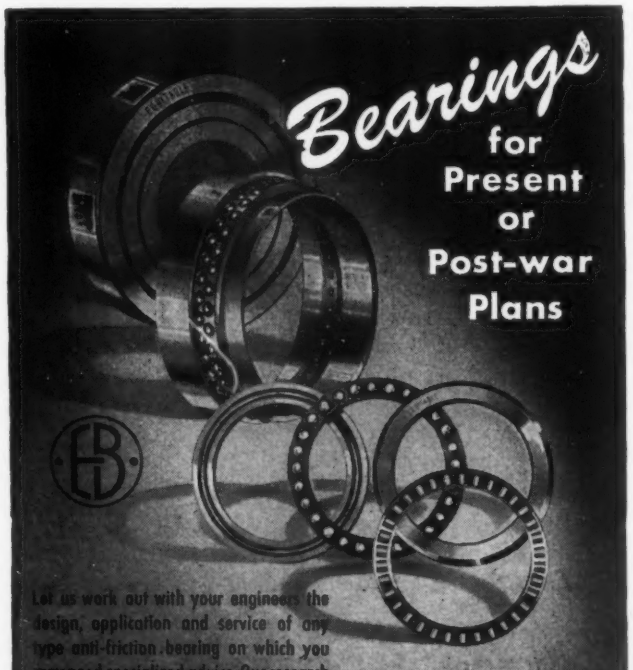
Proportioning Pumps — Force Feed Lubricators — Chemical Valves — Air and Water Valves — Marine Valves — Magnesium Alloy Castings



Let us work out with your engineers the design, application and service of any type anti-friction bearing on which you may need specialized advice. Our research into the operation and performance of bearings—their stress, load and service conditions—qualifies us to be helpful to you in governing your design of Ball and Roller bearings. Thirty-two years engineering experience in the making of high quality, smooth precision, heavy duty, special design and standard bearings over 100 MM. O.D.

Write or phone for new Catalog giving full particulars.

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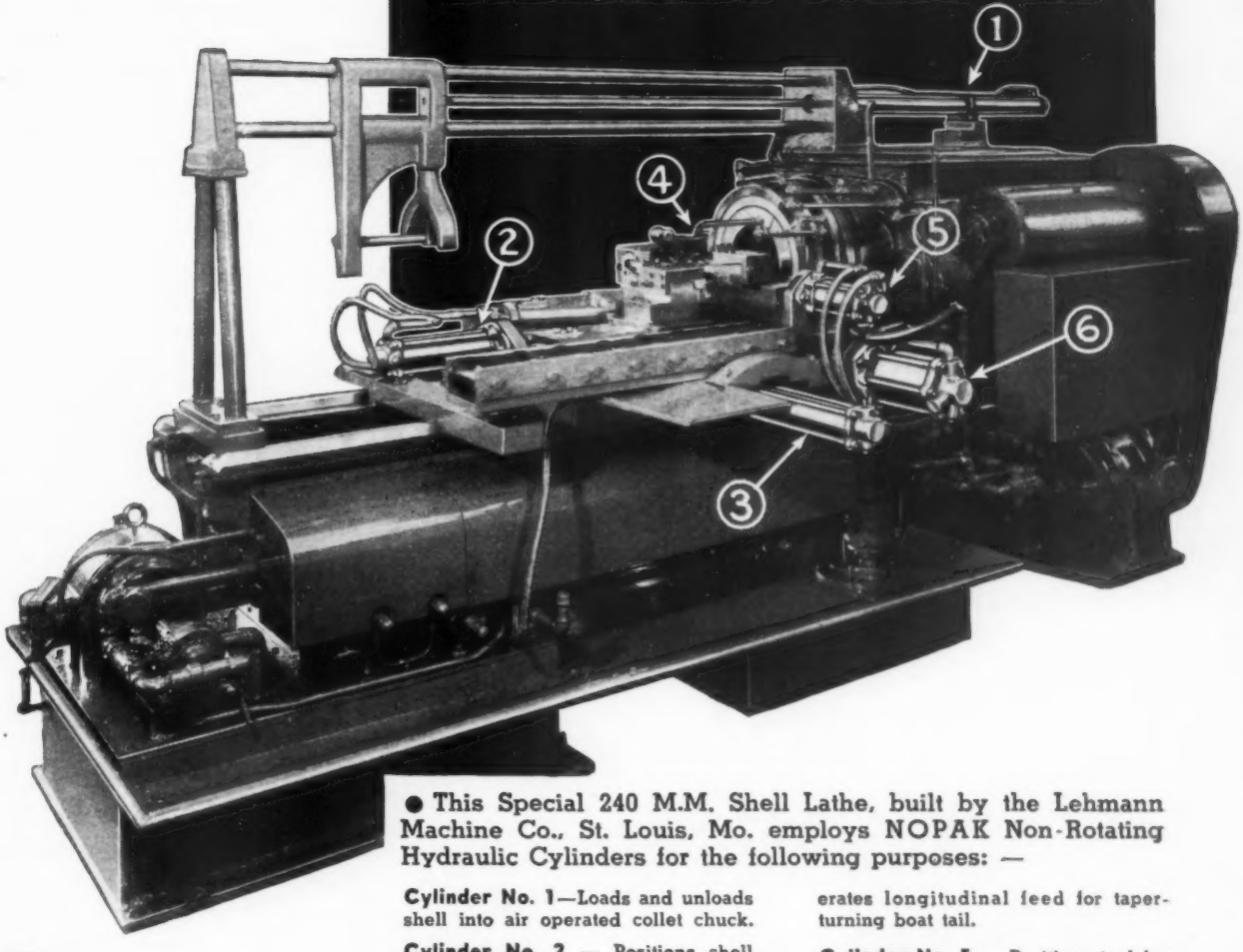
6 Vital Functions

ACTUATED BY 6 NOPAK HYDRAULIC CYLINDERS



● This Special 240 M.M. Shell Lathe, built by the Lehmann Machine Co., St. Louis, Mo. employs NOPAK Non-Rotating Hydraulic Cylinders for the following purposes: —

Cylinder No. 1—Loads and unloads shell into air operated collet chuck.

Cylinder No. 2 — Positions shell for cutting off and facing base.

Cylinder No. 3 — Motivates cross slide feed for cutting off and facing base: also to undercut base groove for cover plate.

Cylinder No. 4 — (Not visible) Operates longitudinal feed for taper-turning boat tail.

Cylinder No. 5 — Positions tool for turning boat tail; coordinates with Cylinder No. 4 for automatic cycle of movements.

Cylinder No. 6 — Operates cross feed to turret slide for grooving, undercutting and waving band-groove.

Lehmann, like other machine tool builders, has incorporated NOPAK Cylinders into the design of equipment for various purposes. The six vital functions pictured here may suggest similar applications for cylinder power in your products.

Write for Illustrated Bulletins.

GALLAND-HENNING MFG. CO., 2762 S. 31st St., Milwaukee 7, Wis.

Model D
NOPAK
Non-Rotating Cylinder

● For right angle flat base mounting on any flat surface in which an opening can be provided for the protruding cushion boss and rod extension.

NOPAK

VALVES AND CYLINDERS

DESIGNED for AIR and HYDRAULIC SERVICE

OUT OUR WAY
BY J. R. WILLIAMS
WHAT C'N I DO? IT'S THE OLD BOTTLE-NECK AT THE PLANER. AND WHAT'S THE BIG RUSH ANYWAY?
V-J DAY—THAT'S THE RUSH—GET MORE PLANERS—GET TWENTY, THIRTY OF THEM ...BUT GET 'EM!
V-E DAY WAS JUST ANOTHER DAY TO THE OLD BULL.
HE WON'T TAKE A HOLIDAY UNTIL OUR AMERICAN FLAG IS FLYING OVER TOKYO!
"JUST ONE LITTLE WORD"
J.R.WILLIAMS

The Old Bull Takes No Holiday

V-E Day didn't curl a hair on the Old Bull's head. He's still in there pitching for all he's worth to bring V-J Day along way ahead of schedule. So he and thousands like him are still pouring out their fast, mass-produced, high precision equipment to hasten the day of final victory.

We, too, are still at it—going full-speed ahead on war work. If you have a wartime or a postwar problem—we will be glad to help.

(Below) Some of the many thousands of our precision parts that help "Keep 'em flying and fighting." Let's all back the attack—Buy EXTRA War Bonds.

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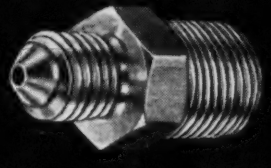

ERICSSON

SCREW MACHINE PRODUCTS CO., INC.

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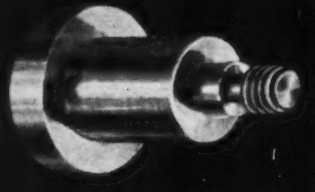
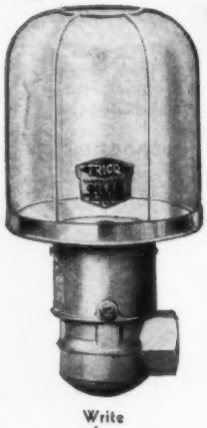


DON'T GAMBLE with HAND OILING



Old fashioned, trust-to-luck hand oiling methods cause waste, guesswork, lost production and sabotage round-the-clock schedules.

Leading machine builders and designers interested in maximum bearing life, customer satisfaction, greater machine value and up-to-date appearance have already switched to TRICO Visible Automatic OILERS.

Investigate the many plus-values TRICO OILERS will add to your machines. There's a type for every application.

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TRICO FUSE MFG. CO.
Milwaukee 12, Wisconsin.

INSTALL TRICO OILERS
REG. U.S. PAT. OFF.

adeco...

NOZZLE TESTER

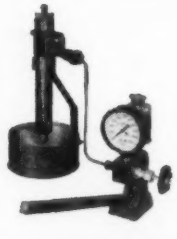
Keeps Diesel Engines Running Efficiently

To keep diesel engines operating at peak efficiency, this portable, precision-built Adeco Nozzle Tester is indispensable.

Light in weight yet built for heavy-duty service, it enables any mechanic to make quick accurate tests on injector opening pressure, spray pattern, etc. and detect stuck needle valves and leakage around valve seats. Tests both large and small injectors, on bench or engine, at pressures up to 10,000 p.s.i. Prevents costly delays and possible damage to engine.

Ideal for testing hydraulic devices.

Write for bulletin on this practical, low-cost unit.



TESTS FUEL INJECTORS AND HYDRAULIC DEVICES at Pressures up to 10,000 p.s.i.

AIRCRAFT & DIESEL EQUIPMENT CORP.
DEPT. 23: 4411 N. RAVENSWOOD AVE.
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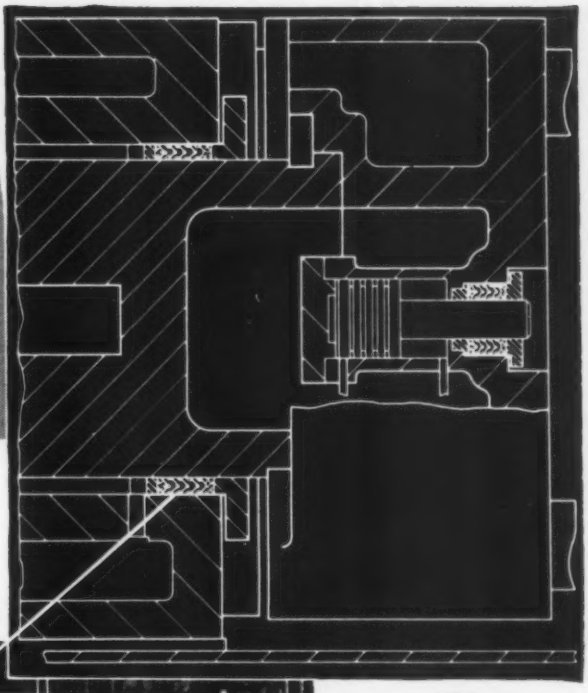
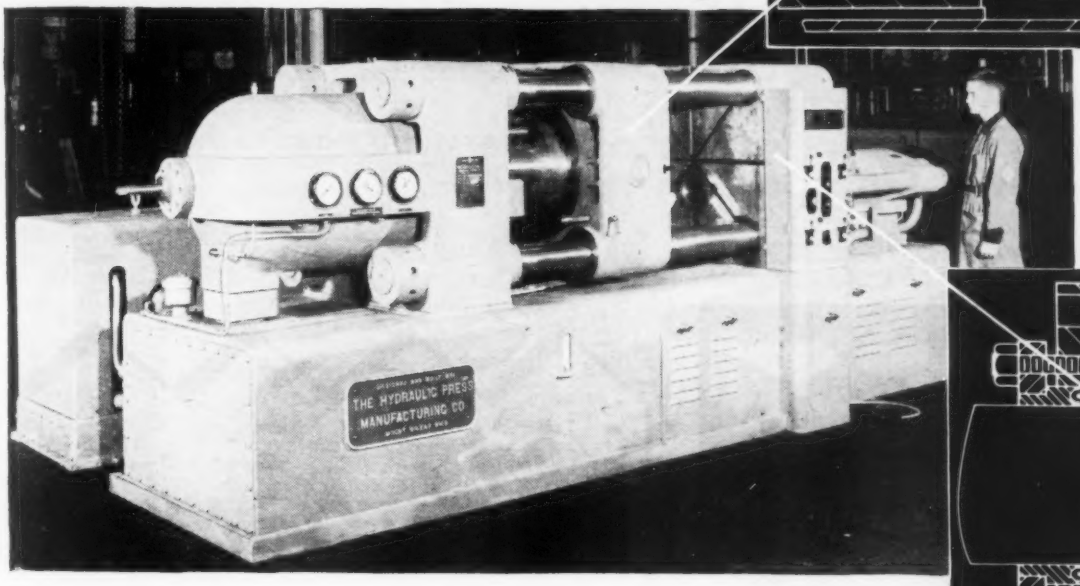
ADECO

HIGH PRESSURE Die Casting . . . at High Speeds AIDED by . . .

LINEAR "Par" Packings





HPM

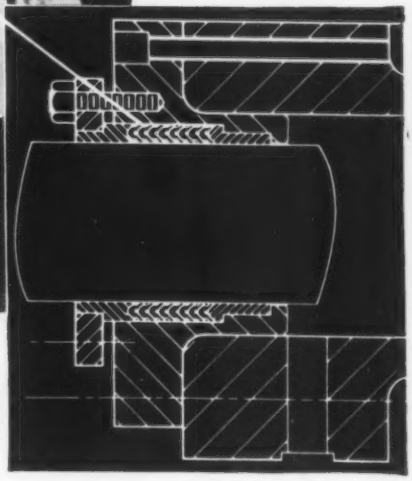


Photo of 400-Ton Die Casting Machine and sketches showing application of Linear "Par" packings to clamp and injection end . . . courtesy of The Hydraulic Press Mfg. Co., Mount Gilead, Ohio.

The H-P-M "All-Hydraulic" die casting machine (illustrated) with standard plunger speeds up to 7200 inches per minute, employs Linear "Par" packings to effectively *seal in* the hydraulic power actuating the high speed, straight-line mold clamp and the very fast injection plungers.

Linear's distinctive design insures a completely automatic packing. As pressure develops the lips expand —and expansion is proportionately reduced when pressure is lowered. Maximum efficiency and uniform pressure maintenance are assured and extreme friction and wear are eliminated.

Made in six compositions, each for a particular service, Linear "Par" packings are specified by hydraulic equipment designers to safeguard hydraulic power from zero to peak pressures—and carefully to control hydraulically operated mechanisms throughout the operating cycle.

Engineering consultation invited . . . sample rings sent upon request. The resources of our testing laboratories and facilities for the complete design of the hydraulic unit itself are available.

LINEAR INCORPORATED

STATE ROAD & LEVICK STREET
TACONY, PHILADELPHIA 35, PENNA.

Better Spring Performance through correct surface Treatment!

The plating and finishing of springs involves many considerations which may affect spring action—unless carefully handled. A special Plating Department at Raymond's rounds out a complete spring service—offering a wide choice of finishes under the experienced judgment and control of specialists in this field. Zinc, cadmium, nickel, copper-dip, Houghto-black—these are some of the finishes which can add life to springs which work under corrosive conditions. Ask Raymond engineers when and how they should be used.

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WIRE FORMS SMALL STAMPINGS

RAYMOND MANUFACTURING CO.
DIVISION OF ASSOCIATED SPRING CORPORATION
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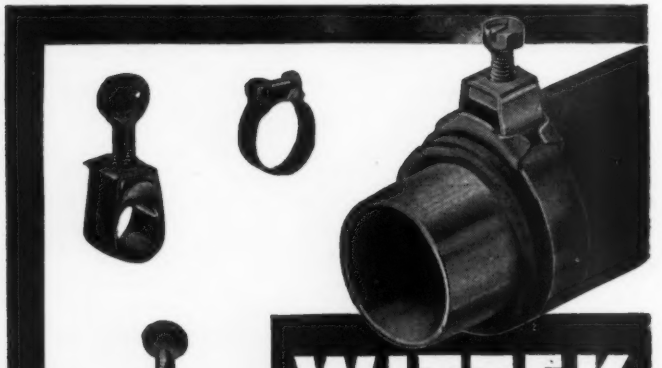

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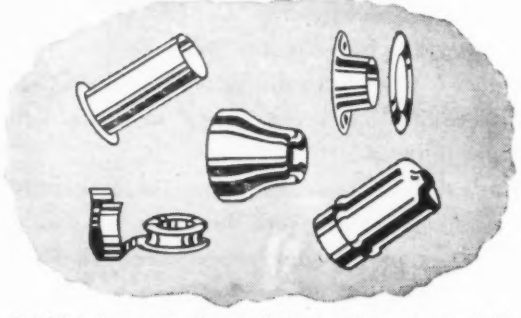
HOSE CLAMPS
For All Applications

The dependability of Wittek Hose Clamps, long accepted by the automotive and aviation industries, is now being proven by actual service with the armed forces of the United Nations as standard equipment for aircraft, tanks, jeeps, trucks, ships and other combat vehicles. Wittek Hose Clamps are made in many different sizes and types for all applications. Write for new descriptive catalog. Wittek Manufacturing Co., 4305-15 West 24th Place, Chicago 23, Illinois

WITTEK WMCo **HOSE CLAMPS**
Dependable Hose Connections

WC INC 1812

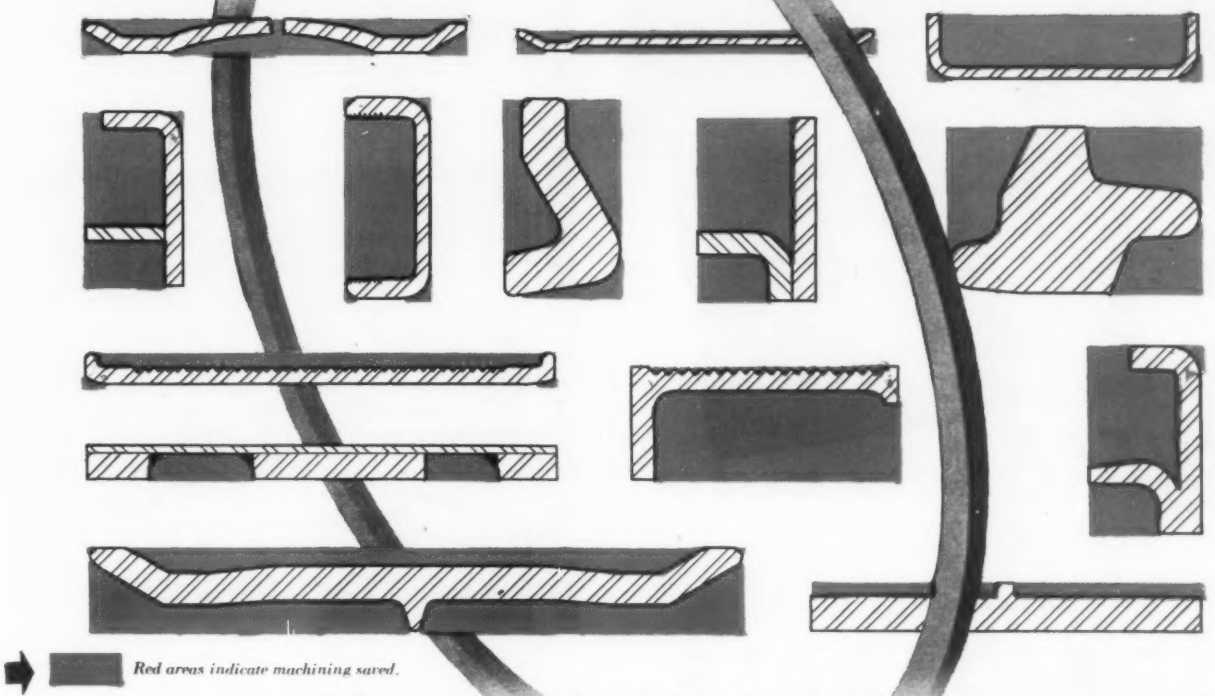
WATERBURY
METAL PARTS



Let Waterbury make the small sheet metal parts needed in your manufacturing. We can supply from stock most standard eyelets, terminals, and ferrules. Also Special Metal Parts to order and Custom Plastic Molding. Write for further information or quotations.

WATERBURY COMPANIES, INC.
Formerly Waterbury Button Co., Est. 1812
DEPT. L. WATERBURY, CONNECTICUT

Cross-section of Ring Making at Dresser



Red areas indicate machining saved.

. . . use this experience to save ring costs

For more than 50 years Dresser has been making rings of all types, with a wide variety of cross sections. From this long experience Dresser has accumulated a "know-how" which is now saving time, manpower, equipment, material and machining costs in the production of circular parts for War and Industry.

Dresser has manufactured all the above cross sections at some time or other—in many diameters. These rings are produced by rolling and welding special mill sections. Some cross sections are obtained by combining rings, shrinking or expanding to make the required assembly.

In all of these rings, expensive machining is saved. Sections have minimum dead areas to be machined . . . and finished dimensions are so accurate that in many cases no further machining is necessary.

Extensive facilities are available for quantity production, and expert engineering service is available to help you redesign your product for welded construction. Whatever your product or problem, send us your inquiries for rings of any shape or size.

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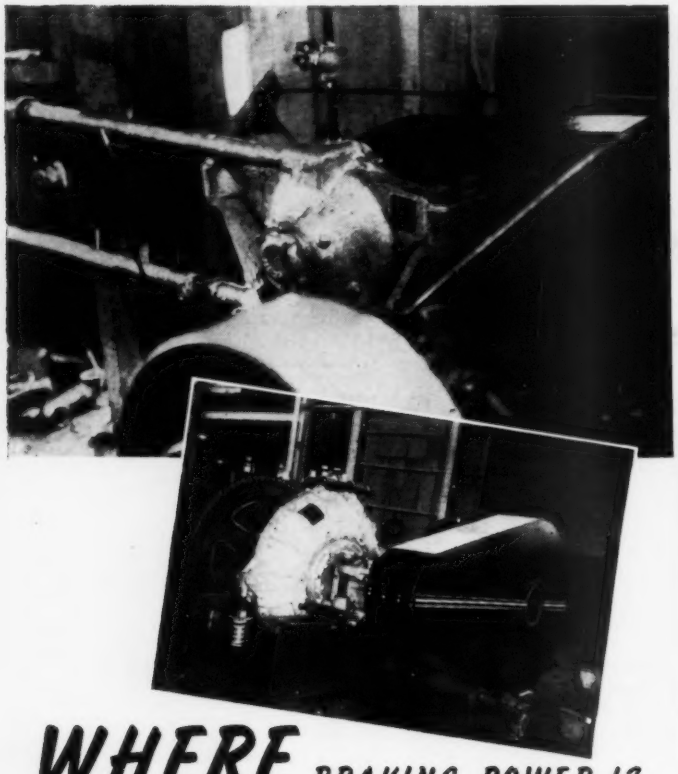
DRESSER MANUFACTURING DIVISION
Bradford, Pennsylvania
In Canada: Dresser Manufacturing Co., Ltd., 60 Front St., West, Toronto, Ontario.

DRESSER **RINGS and FORGINGS**

ONE OF THE DRESSER INDUSTRIES



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TYPICAL APPLICATIONS:

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It will pay you to get the facts about HYDROTARDER for your braking problems . . . . write us, addressing Department P.

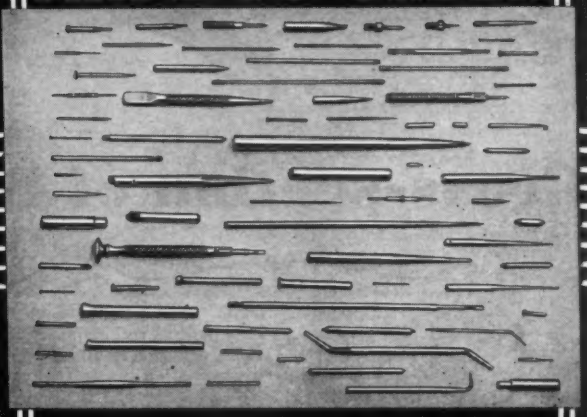
THE PARKERSBURG RIG & REEL COMPANY

Parkersburg, W. Va.

PARKERSBURG

Manufacturers of Quality Products Since 1897

MADE TO ORDER



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Single and double tenon studs turned on specially designed machines, held to close diameter tolerances, with no cut-off burrs.

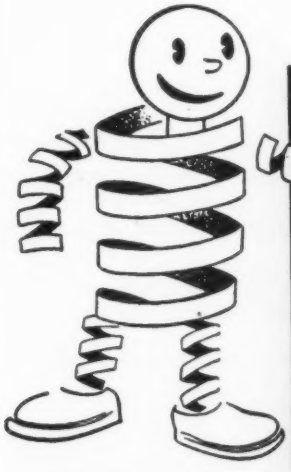
Uniform heat treatment assured with the very latest equipment.

The Torrington Company

SPECIALTY DEP'T.

Torrington, Conn., U.S.A.

"COIL SPRING" Says



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COMPRESSION
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WIRE FORMS

You can't beat U. S. STEEL WIRE SPRING deliveries if you have high priority rating. Nor can you beat the quality that comes from long experience — modern equipment — and capacity to handle urgent requirements on schedule. Direct your next order to U. S. Steel Wire Spring for speed and dependability.

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The U. S. Steel Wire Spring Co.

7800 Finney Ave. **Cleveland, Ohio**

Optics speed the development of television

One of the important steps toward better reception in television is a cathode ray tube face plate which is ground and polished to precision specifications. It is an essential element in the improved optical systems that result in larger, sharper images.

The new science of electron-optics is already an old story in our plant. For one of our most important assignments is the volume production of the face plates, mirrors and other optical components so necessary to the electronics of modern war. Work of this nature is helping our compact group of optical technicians to perfect the very skills that television manufacturers need.

We have developed new machine techniques with which we can hold the closest tolerances when necessary. This assures mass production and economy without loss of quality. These advantages will be particularly interesting to manufacturers who face speedy reconversion in a competitive market.

Our specialty is "custom-built" optics. We make no complete products of our own but work exclusively for other manufacturers. Our optical technicians will be glad to help you toward reconversion. Possibly you have a problem for which we already have a solution.

for precision OPTICS *come to*

AMERICAN LENS COMPANY, INC.

45 Lispenard Street, New York 13, N. Y.

LENSES • • • PRISMS • • • FLATS • • • REFLECTORS

Quick-As-Wink

On automobile core machines, positive control is essential.

The Quick-As-Wink hand operated 4-way compound exhaust valve controls the inner and outer movement of the two horizontal cylinders. The hand operated 3-way Quick-As-Wink valve controls the upward movement of the center vertical cylinder.

C. B. Hunt & Son manufactures solenoid, hand, foot, and diaphragm operated valves for air, also hand and pilot operated hydraulic types for water or oil applications up to pressures of 5,000 pounds, in standard and special sizes.

This automobile core machine is a product of The Tabor Manufacturing Company, Philadelphia, Pa. Two Quick-As-Wink valves assure positive air control.

The Hunt catalog carries complete, easy-to-use engineering data. Write for a copy.

AIR WATER OIL — THE HIGHER THE PRESSURE THE TIGHTER THE SEAL

C. B. HUNT & SON
1850 E. PERSHING STREET
SALEM, OHIO

In The Bendix-Weiss Rolling Ball Universal Joint

Here Shown Disassembled

STROM BALLS
Serve the Armed Forces

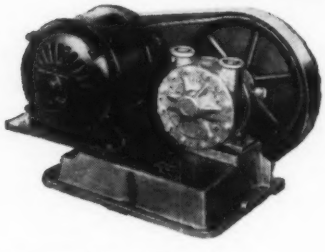
Here, in the Bendix-Weiss Constant Velocity Universal Joint, Strom Balls do their parts in making miltary vehicles, from Jeeps to 14-ton Armored Cars, the efficient fighting equipment that they are. This is only one spot in our great war production effort where the high degree of perfection of Strom Balls serves industry, enabling it to provide the finest bearing equipment towards its great contribution to total victory. Strom Steel Ball Company, 1850 South 54th Avenue, Cicero 50, Ill.

Largest Independent and Exclusive Metal Ball Manufacturer

Strom BALLS Serve Industry

WHEN YOU NEED PRECISION-BUILT SMALL PUMPS . . . *Specify* TUTHILL

For Handling Viscous Liquids . . .
IT'S THE TUTHILL V-BELT UNIT



Tuthill compact V-belt pumping units make light work of handling heavy liquids. Simple in construction and quiet in operation, they are built for long service with negligible maintenance. Features include internal-gear rotary pumps, outboard ball-bearing shaft support, belt tension adjustment by one set screw, wide range of speeds, capacities and pressures. Write for viscous liquid pump bulletin.

Tuthill Pumps are serving Army Navy • Air Force • Merchant Marine and Industry

TUTHILL PUMP COMPANY
939 EAST 95TH STREET • CHICAGO 19, ILLINOIS

What has Star got?

Before you pick any motor to power your postwar product we'd like to submit 3 teasers . . .

(". . . and I know 'em all!")

Why did a famous maker of Materials Handling Equipment* not long ago say — "There isn't a Brake Motor built that can touch that Star, and I know 'em all"?

(". . . you like 'em tough")

Why did one of the world's biggest makers of Machine Tools* recently choose Star to work with on a tough application problem?

(". . . laying it in your lap")

Why did a noted Dairy Machinery company* pick Star to develop a unique small Generator for their new machine?

*(*Name on request)*

We needn't tell you that buyers like these three are motor-wise, and hard-boiled in their determination to obtain the most satisfactory solution to powering their products. . . .

And we needn't tell you that we have engineering brains second to none, or that we have excellent production facilities. Without them, we could not get to first base. . . .

What, then, is the "something extra on the ball" we *must* have to lead such concerns to choose to work with Star on their new products?

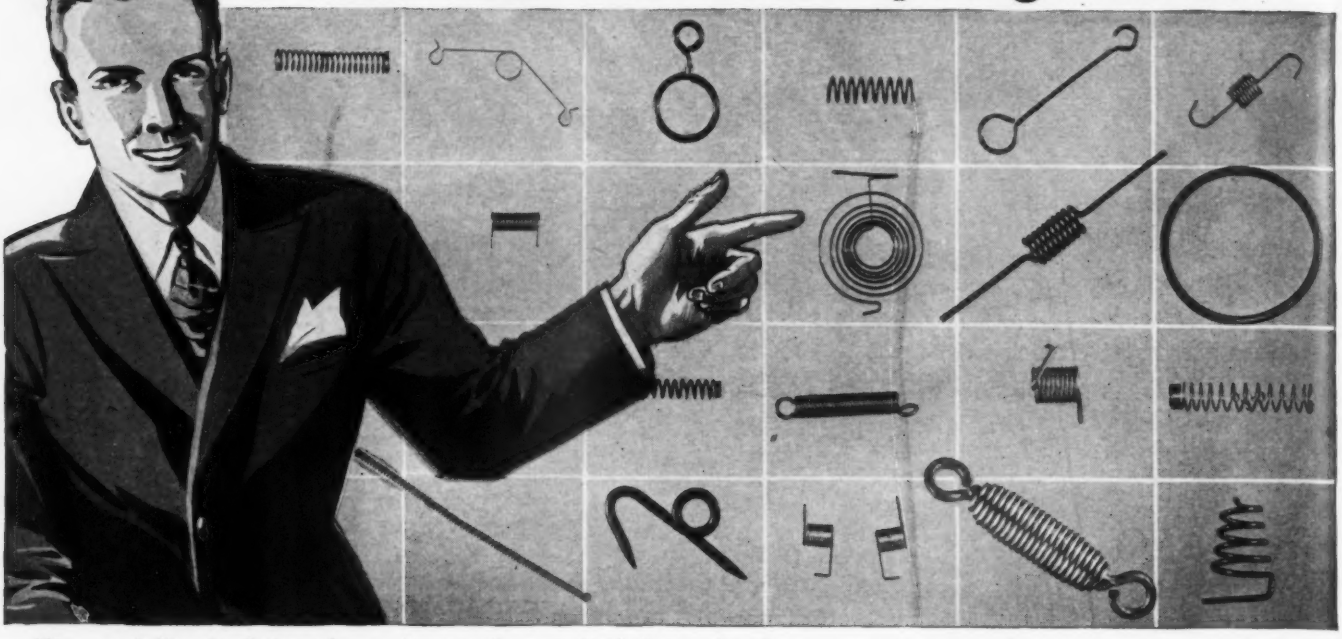
You'll find it's Star's approach to a motor problem – a willingness to give your job "top billing". There's no stop-watch on the brains applied to your problem – and there are not so many problems that we can't apply our best brains to all.

That's why you, too, will choose wisely by making Star your postwar "Motor Department". Our designing facilities can be placed at your command NOW, to solve any problems not covered by standard Star Motors, from ⅛ to 200 HP, some of which are available for early delivery. Star Electric Motor Co., 200 Bloomfield Ave., Bloomfield, N. J.

STAR MOTORS

POWER PACKAGED AS YOU NEED IT

Do You See *Your* Spring Here?



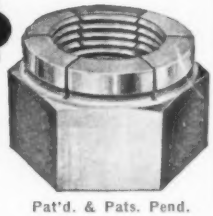
We specialize in fitting the spring to the need! If the spring for your postwar product is not pictured above, describe how and where it will be used and our engineers will suggest the right design for the job. This holds good also for your present products. The performance of many an existing appliance or machine could be materially improved merely by supplanting old springs with new ones "engineered" into the design. Peck Springs are made up to ⅛" wire size. Let's get together.

THE PECK SPRING CO., 33 SUMMIT ST., PLAINVILLE, CONN.

Peck SPRINGS & SCREW MACHINE PRODUCTS

Why you should order the

FLEXLOC



STOP and LOCK NUT

Pat'd. & Pats. Pend.

Because:

- It is of one-piece construction
- It can be made of any of the conventional nut materials
- Every thread—including locking threads—takes its share of the load
- **Its construction is especially advantageous for maximum strength and dependability of low and thin nuts**
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- It can be used over and over again without losing its ability to lock
- It is not affected by temperatures likely to be met within the field of Mechanical Engineering
- Being a "stop" nut, it stays locked in any position on a threaded member.

Sizes from No. 6 to 1" diameter
Millions in use—write for Bulletin #582

The famous "Unbrako" Socket Screw Products are also made by us.

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OVER 40 YEARS IN BUSINESS

WHY We Cracked the Bearing in Two-

Every engineer faces this problem. How can a ball bearing be installed on crankshafts, gear clusters, shaft flanges, connecting rods and similar apparently inaccessible places? Our Engineering Staff went to work. They found the answer. By a special patented process — we cracked the bearing in two. Result: a Split Bearing, made to A. B. E. C. I precision tolerances — that gives the same performance as a solid race bearing, PLUS the fact that it is divisible. Made in ball or roller, in radial or thrust type, for efficient, long-life performance.

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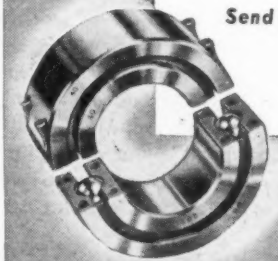

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SPLIT BALLBEARING CORPORATION

LEBANON, NEW HAMPSHIRE. U. S. A.

5-WAY THREAT
in the Pacific

ONE OF THE NAVY'S most effective offensive weapons is the Corsair, designed by Chance Vought Aircraft. Called the "5 in 1 Threat," because it operates as a land-based fighter bomber, land-based fighter, carrier-based fighter bomber, carrier-based fighter, and night fighter; the Corsair is one of the Navy's most versatile and powerful war planes.

Almost from the plane's inception, through its major improvements and modifications, Solar has collaborated in the design and supply of Exhaust Stacks.

Solar engineering and manufacturing skills in the fabrication of high temperature alloy products for handling hot gases and waste heat energy have led the aircraft industry since 1930. After Victory, they will be available to manufacturers in other fields.

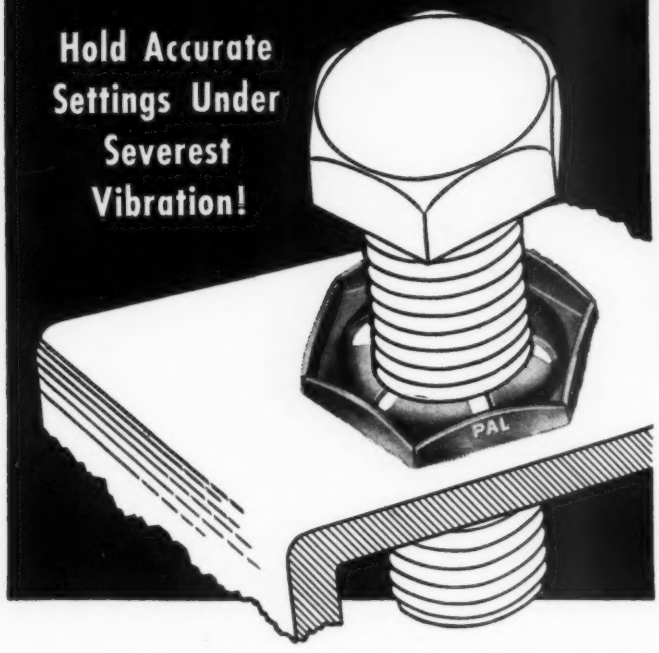
SOLAR

STAINLESS STEEL PRODUCTS

SOLAR AIRCRAFT COMPANY ★ SAN DIEGO 12, CALIF. ★ DES MOINES 5, IA.

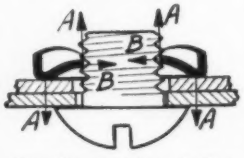
Use PALNUTS to lock Set Screws in Position!

Hold Accurate Settings Under Severest Vibration!



A set screw that won't "stay put", is soon valueless. To maintain accurate set-screw settings, lock them with Palnuts instead of regular hex nuts or jam nuts. This provides a powerful double-locking action* that is unmoved by severe, prolonged vibration.

Single thread, tempered spring steel Palnuts require only 3 bolt threads space. They spin on fast with fingers, lock tight with 1/4 to 1/3 turn of wrench. Cost no more, and frequently less, than regular nuts; may be re-used. Full line of sizes in National Coarse and National Fine Threads.



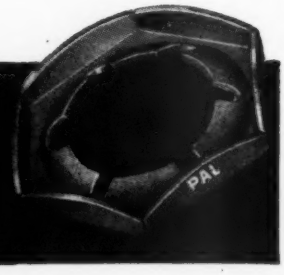
***Double Locking Action**

When the Palnut is tightened, its arched slotted jaws grip the bolt like a chuck (B-B), while spring tension is exerted upward on the bolt thread and downward on the part (A-A), securely locking both.

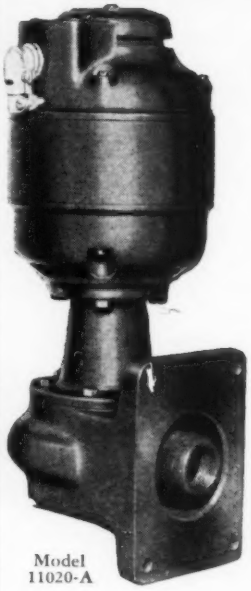
WRITE for Palnut No. 2, giving engineering data on Self-locking Palnuts. Outline requirements for samples.

THE PALNUT COMPANY
65 Cordier Street,
Irvington 11, N. J.

SELF-LOCKING PALNUTS



designed to SAVE MONEY



Model 11020-A

RUTHMAN GUSHER COOLANT PUMPS

You save money three ways when you specify Ruthman Gusher Coolant Pumps on your machines. Sturdy, simple construction reduces maintenance costs . . . Steady uninterrupted flow of coolants allow you high precision production on your machined parts . . . and long trouble free life minimizes replacement costs.

There's a Gusher For Every Requirement. Write now for catalog.

THE RUTHMAN MACHINERY CO.
1813 READING ROAD
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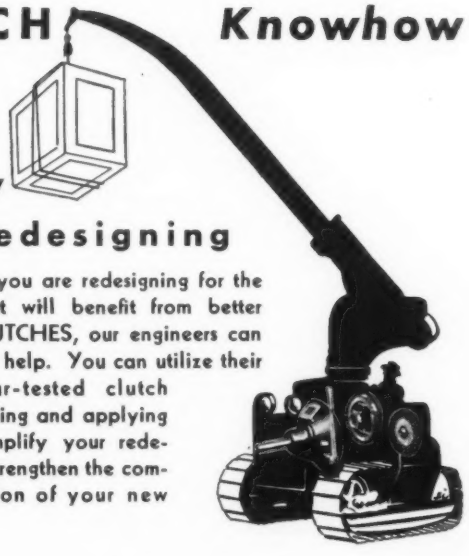
The "GUSHER"—A Modern Pump For Modern Machine Tools

CLUTCH Knowhow That Will Simplify Your Redesigning

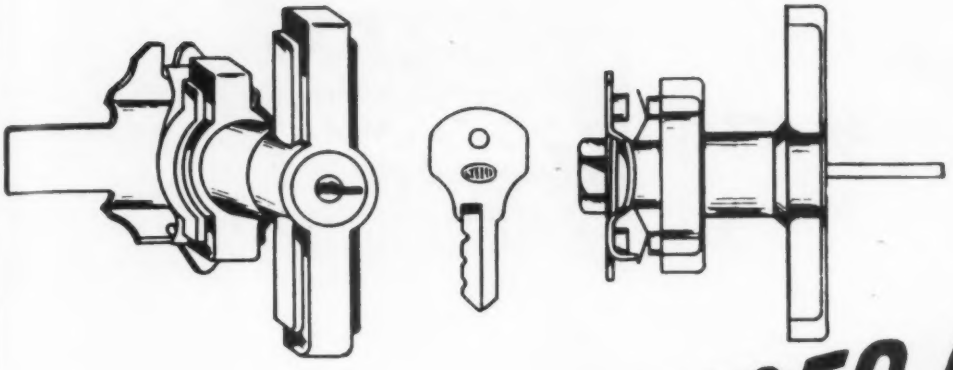


If the products you are redesigning for the post-war market will benefit from better conforming CLUTCHES, our engineers can give you timely help. You can utilize their extensive, war-tested clutch designing, building and applying *knowhow* to simplify your redesigning and to strengthen the competitive position of your new products.

SEND FOR THIS HANDY BULLETIN ON POWER TRANSMISSION
It shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications. Every production engineer will find help in this handy bulletin, when planning postwar products.

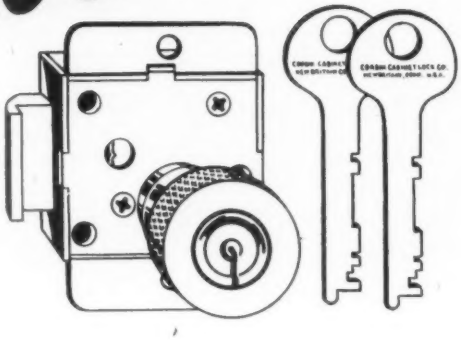
ROCKFORD CLUTCH (FORMERLY KNOWN AS DRILLING MACHINE) **DIVISION** BORG-WARNER CORPORATION
209 Catherine Street, Rockford, Illinois, U. S. A.

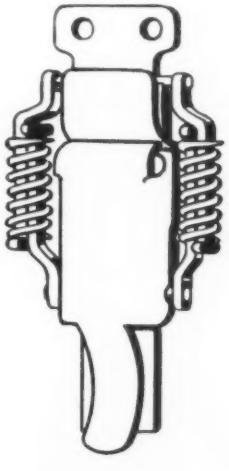
ROCKFORD CLUTCHES



LOCKING DEVICES GALORE

...and good ones, too!





• Locks for cabinets, chests, cupboards and drawers . . . for sliding doors, wardrobes, panel boards, metal products . . . for suitcases, trunks, lockers and commercial truck bodies — they're all carefully indexed and illustrated in our compact "Industrial Catalog." Design engineers everywhere have long found this catalog invariably helpful and time-saving when a stock installation is to be specified. Write for your copy.

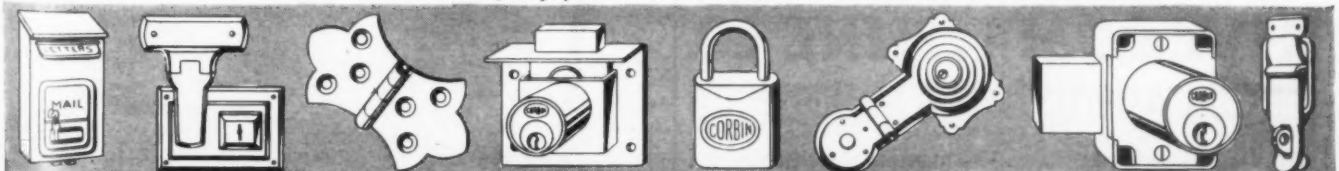
If your design is new or intricate, send us a blueprint or ask a Corbin Lock engineer to drop in. A specialist, he can contribute much that is pertinent design-wise as well as provide the close service follow-through to meet your most rigid requirements.

CORBIN CABINET LOCK CO.

DIVISION OF AMERICAN HARDWARE CORPORATION

NEW BRITAIN, CONNECTICUT

"Safety first . . . and last . . . when Corbinlocked"



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Save Time —

CUT COSTS
AND
SPEED PRODUCTION

Use —

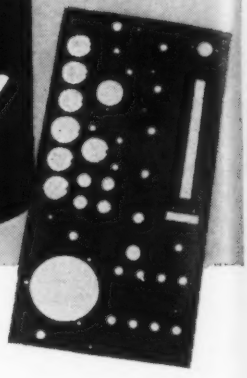
MILFORD
Semi-Tubular
RIVETS

If you are using solid rivets, or some other method of fastening, it might pay you to consult us—at least it doesn't cost anything to find out. Why not drop us a line today?

The **MILFORD**
RIVET & MACHINE CO.

EASTERN DIVISION — CENTRAL DIVISION
MILFORD, CONN. ★ ELYRIA, OHIO.

There is no substitute for
PRECISION
in metal parts fabrication



"This instrument panel is representative of the accuracy and tolerance specifications regularly handled by OLYMPIC. Critical electronic applications are ordinary production here."

Mass production methods demand high dimensional accuracy today, particularly where replacement parts must be readily interchangeable. The experience and manufacturing techniques of OLYMPIC assure strict adherence to dimensional limits in sheet metal working.

OLYMPIC metal fabrication facilities are available for the accurate and precise fulfillment of your needs. Stamping, forming, tooling, turning, drawing, grinding, soldering, welding or brazing, etc.—all are accomplished to your exact specifications. Any finish can be supplied.

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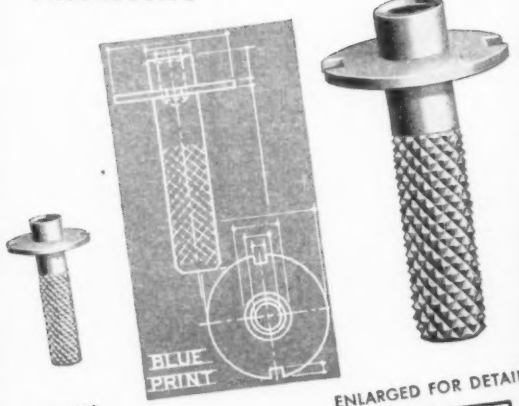
TOOL & MFG. CO., INC.
39 CHAMBERS ST., NEW YORK 7, N. Y.

CRAFTSMANSHIP IN METAL PARTS

ANOTHER SPECIAL BY PROGRESSIVE

QUALITY PROMCO BRAND



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Special heads, threads and finishes on any metal or alloy adapted to cold upset. Weekly output: 25,000,000 pieces. Many specials, suggesting production savings for you, illustrated in latest catalog. Includes weights per 1M standard pieces, decimal equivs. of fractions, other purchasing and engineering helps. Write for Catalog 18.

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48 NORWOOD ST. TORRINGTON, CONN.

★ BUY MORE WAR BONDS ★

Designing in RUBBER?

PERHAPS WE CAN HELP YOU!

Do you have problems in design, which could be satisfied by a rubber part? If so, we can be of help to you. Good design in rubber requires a knowledge of the properties of the various rubber compounds, plus an understanding of the production problems involved. We understand rubber design and production, and as specialists in rubber production, we offer our knowledge to you.

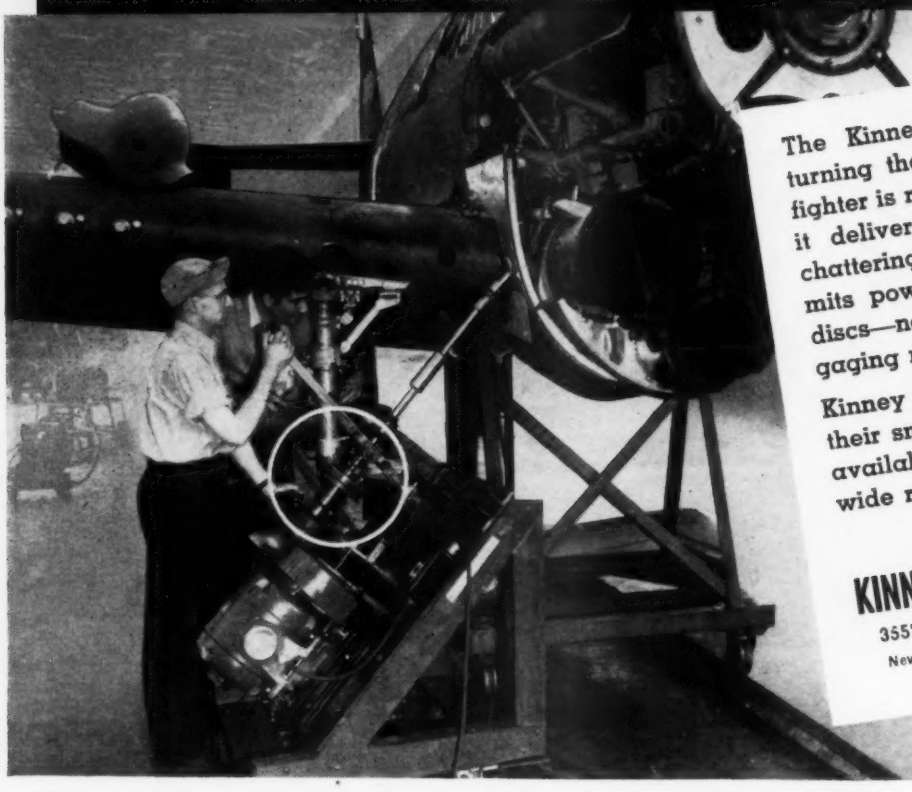
The following questions are typical in rubber design:

Should it be made in natural or synthetic rubber?
What atmospheric conditions must be considered?
What range of temperatures will be encountered?
Are oils, chemicals or ozone prevalent?
Will the part be used structurally?
Must the part have properties to resist abrasion?
Tear? Cold Flow? Set?
Is color a factor in design?
Will the part be a metal bonded part?

These are just some of the factors which play a part in the success or failure of rubber parts. Our experience in rubber is yours to use when you have design problems —write us about your particular job, outline the conditions of operation . . . we will be glad to supply the needed data for good design.

THE AETNA RUBBER COMPANY
815 East 79th Street · Cleveland 8, Ohio

KINNEY CLUTCH



The Kinney Interchange Clutch turning the motor of this Curtiss fighter is rugged and dependable; it delivers high torque without chattering or grabbing, and transmits power directly through flat discs—not through bolts or engaging mechanism.

Kinney Clutches—well known for their smooth, positive action—are available in many types for a wide range of applications.

Send for Catalog K-8

KINNEY MANUFACTURING CO.

3557 Washington St., Boston 30, Mass.

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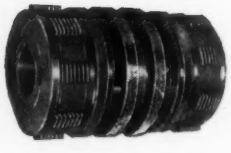
Photo courtesy Curtiss-Wright Corp.

TRADE MAXITORQ MARK

Floating Disc **CLUTCHES**

SINGLE OR DOUBLE



WET OR DRY

SO SIMPLE IN DESIGN

Here, for a fact, is the fool-proof clutch . . . a design so simple, so compact, that once you have taken it COMPLETELY apart by HAND its "secrets" are yours. NO TOOLS are needed for either assembly, adjustment or take-apart. Such parts as the patented Locking Plate (which holds clutch together), the patented Separator Springs (which hold discs apart in neutral), the Multiple Discs, are all simple but dependably efficient.

Engagement and disengagement are positive . . . no slipping . . . no drag, abrasion or heating in neutral.

You have long wanted . . . and needed . . . a clutch with these features. Here it is . . . standard ¼ to 5 H.P. at 100 R.P.M. . . . larger capacities to order.

SEND FOR CATALOG NO. PE7

THE CARLYLE JOHNSON MACHINE COMPANY · MANCHESTER, CONNECTICUT

New England Screw Co.

KEENE, NEW HAMPSHIRE

50 YEARS OF SPECIALIZED EXPERIENCE

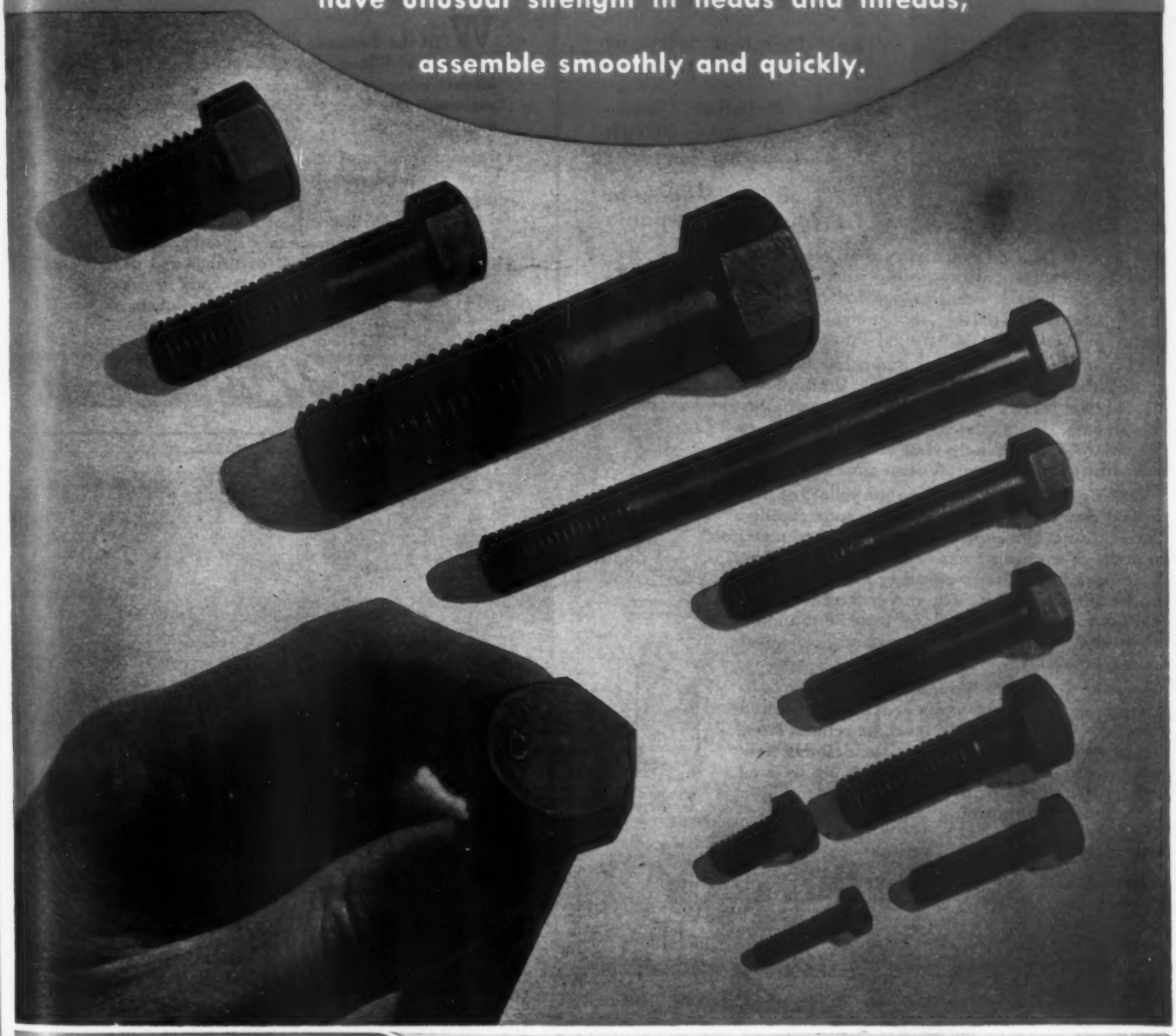
MACHINE SCREWS
SHEET METAL SCREWS
MACHINE SCREW NUTS
PLASTIC INSETS
HOLDING PINS
SPECIAL RIVETS

ALL TYPES OF HEADS AND THREADS

It's good business to use the best cap screws you can buy — for speed in the shop and strength in your finished product.

CLEVELAND *Top Quality* SAE 1035 CAP SCREWS

have unusual strength in heads and threads, assemble smoothly and quickly.



CLEVELAND *Top Quality* **FASTENERS**

The Cleveland Cap Screw Company

2917 EAST 79TH STREET • CLEVELAND 4, OHIO

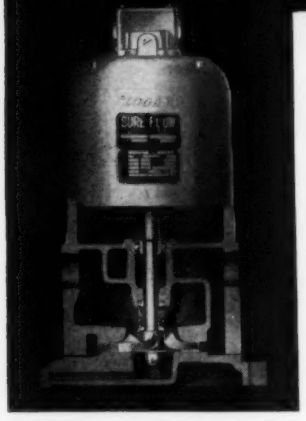
Warehouses: Chicago, Philadelphia, New York, Los Angeles

Ask your Jobber for Cleveland Fasteners

MADE BY THE ORIGINATORS OF THE KAUFMAN PROCESS FOR GREATER STRENGTH AND ACCURACY

Get Higher Pumping Efficiency with...

the NEW, improved *Logan* SURE-FLOW coolant pumps

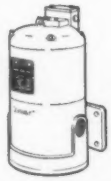


- ✓ New High Efficiency Long Life Impeller
- ✓ Motor Sealed Against Splashing and Grit
- ✓ Self-Priming without Submerging Types*
- ✓ New Grinder, Submerged and High Speed Pumps
- ✓ 27 Standard Models to Fit Your Requirements

For coolant pumping efficiency that keeps pace with today's fast-cutting, high precision machines . . . for peak performance in your future developments . . . specify the new, *improved* Logan SURE-FLOW Centrifugal Pumps.

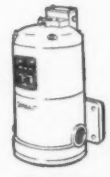
*FOOT MOUNTED

This outstanding coolant pump has been re-engineered from top to bottom to embody exclusive new features and Logan engineering developments. By applying these advantages to your work, you will help your modern machines and cutting tools to operate at maximum capacity.



*BRACKET MOUNTED

The open, unloading type impeller of improved design discharges air or vapor rapidly. There are no close tolerances or metal-to-metal contacts of running parts . . . liquids containing some abrasives, filings or other foreign matter can be handled safely. The integral motor drive permits the SURE-FLOW pump to be mounted anywhere. No gears, chains or other mechanical drive are required.



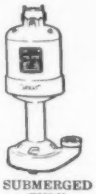
FLANGE MOUNTED (intake thru flange)

Foot and bracket mounted models are *self-priming without submerging* . . . can be located above or below the liquid level, or remote from the supply. The Logan line also includes new *grinder* and *submerged* type pumps, as well as *high-speed* models for driving stream, deep hole drilling and chip flushing applications.

Available in 5 Types

Logan SURE-FLOW Coolant Pumps are now available in 5 mounting types and 27 standard models to fit a wide range of applications. Obtain these profitable advantages for your equipment . . . investigate SURE-FLOW pumps today.

GRINDER TYPE (intake thru flange)



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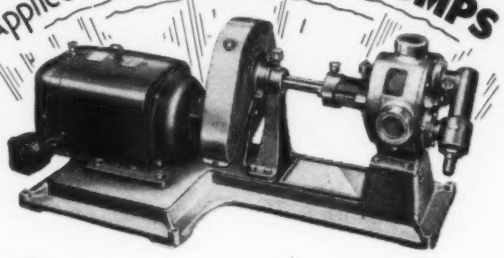
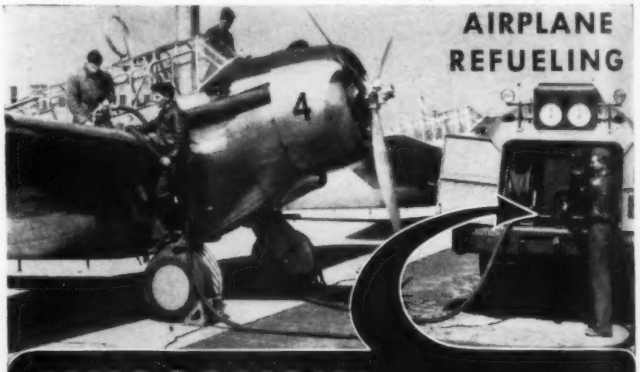


WITH the demands of War placing new responsibilities on Viking Pumps, coupled with Viking's largest selection of Rotary Pumps in the world, the net result has been a wider and still wider application for Vikings.

Take advantage of this wealth of experience. If you have a rotary pumping problem, ask Viking about it today.

Write for Special Folder SP-123x which illustrates many styles and sizes available, as well as listing and describing 30 special bulletins, any of which will be sent to you free on request.

VIKING Pump COMPANY CEDAR FALLS IOWA



WISCONSIN HEAVY-DUTY *Air-Cooled* ENGINES *on the Job*

This Model F-2A Heil 2,000 Gal. Airplane Refueler must be ready for instantaneous service at all times. The responsibility of pumping gasoline from the refueler to airplanes operating on close schedules is entrusted to heavy-duty Wisconsin air-cooled engines . . . an assignment that calls for the last word in steady-going dependability.

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World's Largest Builders of Heavy Duty Air-Cooled Engines

Ideas FOR DESIGN-ENGINEERS—IN THESE USES OF *S.S.White Flexible Shafts*

ONE OF A SERIES showing typical POWER DRIVE and REMOTE CONTROL applications

COUPLING with a length of power drive flexible shafting is an ideal way to make a turn in a power drive. The simplicity and adaptability of the method are readily appreciated from the outboard motor application illustrated. With S. S. White power drive shafts available in diameters from .043" to .750", a wide range of power coupling requirements can be met.

Photo courtesy of Republic Aviation Corp.

Photo courtesy of Le Jay Mfg. Co.

COUPLING with a length of remote control flexible shafting is the simple way to provide remote control for mechanisms requiring rotation. One of thousands of such uses is shown above—the shutter control in the air duct leading to the oil cooler in the Thunderbolt fighter plane. You can readily run a control between any two points with a flexible shaft all the way, or with a combination of solid rods and lengths of flexible shafts for the turns.

FLEXIBLE SHAFT HANDBOOK FREE TO ENGINEERS

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ARMY E NAVY

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COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by the Bridgeport Brass Co. "Bridgeport" *Headquarters for BRASS, BRONZE and COPPER*

Metal Spraying Processes Greatly Extend Industrial Uses For Copper Alloys

Metal spraying has been known for about 40 years yet it is only within the last ten years that its importance to industry has been recognized. Because of the shortage of critical war material and manpower, metal spraying for repairing worn equipment and, for securing surfaces with the desirable qualities of the more expensive metals has greatly increased. What its possibilities will be in the postwar period depends upon the imagination and the engineering abilities of the enterprising firms who comprise the metal spraying industry.

For those who are not too familiar with metal spraying, briefly, this method consists of feeding metal wire into a portable type spray gun which first melts the end of the wire by means of an oxygen-gas flame and then atomizes the molten metal by means of a blast of compressed air which blows it out in the form of a fine, dense spray. Upon reaching the surface, the particles of sprayed metal chill almost instantly and key themselves into the base metal. Although the sprayed metal coats the object, the finely divided metal droplets do not adhere to it as is the case with brazing. To obtain a strong mechanical bond it is necessary to prepare the surface to produce a multiplicity of minute keys or locks for holding the sprayed molten metal firmly to the surface. This is accomplished by several methods such as (1) a special machining or rough threading operation, (2) roughening or blistering the surface by electric arcing, or (3) by blasting with sand or steel grit. Rough threading provides a satisfactory surface for steel shafts but is not recommended for brass, bronze or steels containing nickel.

The wire used may be brass, bronze, copper, silicon bronze, aluminum bronze, aluminum, lead, tin, iron, zinc, cadmium, babbitt, nickel, various types of steels, monel, stainless, etc. It is possible, therefore, to build up worn surfaces of shafts, bushings, propellers, in fact most any pieces of equipment, with the same or with a superior metal or alloy surface. Small parts which cannot be economically sprayed by hand can be sprayed in a tumbling barrel.

An important application has been to use metal spray for corrosion protection—pure aluminum on duralumin sheets or castings for airplane construction and zinc on steel to replace hot galvanizing. Bronze on steel powder tanks is applied to prevent the danger from sparking. Copper on carbon brushes, soldering surfaces of tin on glass, stainless steel on carbon steel are other common applications. Metal spraying is also used to impart a tough surface to parts subject to wear, thus eliminating the necessity of making the entire unit from a hard-to-machine or more expensive material. Sprayed metal is also used for decorative purposes and takes the standard metal finishes.

Two stages in the production of pistons used on landing gear of P-47 aircraft, following spraying with bronze. The left piston is rough machined and later given the required high finish, with oil grooves, as shown in the view at the right.

An interesting application of metal spraying, as a manufacturing process, is its use for making bronze faced pistons for the Aerol Landing strut used on fighter planes.

Neo Mold Company of Cleveland, Ohio, designed comparatively light steel blanks and sprayed them with Bridgeport bronze to a thickness of about 0.045" on the bearing surface. This is first rough machined, then highly finished with oil grooves. Originally strut pistons were made from bronze castings, and each weighed about seven pounds as compared to about three and one-half pounds for the steel with the bronze bearing surface. The chief advantage is that the bearing qualities of bronze are combined with the strength and rigidity of steel. Since sprayed metal has an extremely fine porosity, the sprayed bronze absorbs and retains oil and becomes self-oiling after short use.

This method is being applied to all types of pistons for compressors and pumps and has fine postwar possibilities. One interesting application is bronze sprayed on aluminum to produce an extremely light, machineable oil bearing that is long wearing. Another interesting application of bronze spraying is the restoration of large bronze paper mill rolls worn and corroded in a number of places between perforations.

Maintenance Applications

Mostly, however, metal spraying is used for repair purposes, salvaging and maintenance. Another important application for metal spraying is designed to prolong the life of equipment subjected to high annealing temperatures. Salt pots, annealing boxes and furnace equipment have been treated successfully to increase service life.

Not all alloys in the form of wire are suitable for use in metal spraying because it is necessary that the sprayed molten metal take the form of tiny balls of metal and not break up into fine dust after it leaves the spray gun. All Bridgeport welding bronze alloys, also possess the necessary qualifications for use in metal spraying because they are specially prepared so that they are free from oxides which are harmful. Micrographs of sprayed metal show that it is made up of tiny particles which are flattened and interlocked. The strength and ductility of the sprayed metal is governed by its physical make-up and not by the physical properties of the wire before it is sprayed. There are a number of additional copper-base alloys, which when processed properly, can be used for special applications. Here much help as to the selection can come from our metallurgical laboratory staff.

Manufacturers of spray guns and accessory equipment have made much progress in the art of metal spraying. Better methods of surface preparation are constantly being developed to increase the strength of the mechanical bond between the base metal and the sprayed material. Improvements are also constantly being made in the spray gun itself in the use of multiple gun setups and in devices to permit automatic operation without sacrificing quality. Metal spraying, of course, has its limitations. The industry looks forward to the day when metal spraying will be commonly used as one of the necessary operations for manufacturing machinery, equipment and the countless everyday articles.

COPPER ALLOY BULLETIN

CAUSES OF CORROSION

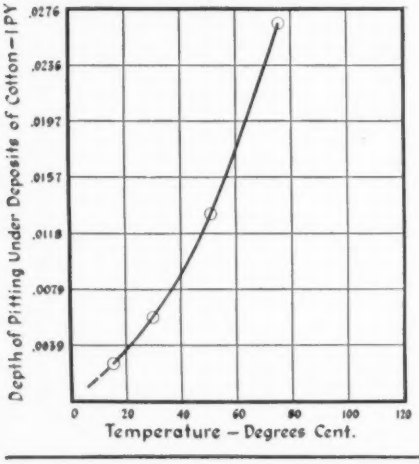
This article is one of a series of discussions by C. L. Bulow, research chemist of the Bridgeport Brass Company.

REDUCING THE HOT WALL EFFECT

As previously stated, the rate of corrosion is increased by high local temperature. This is illustrated by the curve shown in figure A. As low a temperature as possible should be maintained, and uninterrupted heating kept down to a minimum. In addition, all possible steps should be taken to prevent the repeated formation of bubbles of gas in the same location either by constantly shifting the point of bubble formation or where feasible by removing the dissolved air or gas from the liquid before it is heated. The deposition of foreign material on the metal surface should be avoided.

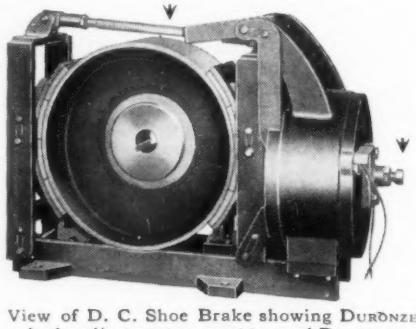
Sometimes it is very difficult to take the steps necessary to prevent the hot wall effect from accelerating corrosion. There are, however, a number of instances where a consideration of the mechanism of the acceleration of corrosion by the "hot wall effect" has resulted in a marked decrease in the corrosion rate. For example, in shell and tube type heat exchangers a corrosive cooling water passing through a metal tube with only a slightly corrosive hot liquid on the outside may fail prematurely. On the other hand, a tube of the same composition but with the hot liquid passing through the tube and cooling water flowing around the outside of the tube will have a normal life. In this instance the rapidly flowing water prevents both the formation of bubbles of gas and the deposition of certain types of foreign material.

EFFECT OF TEMPERATURE ON RATE OF CORROSION OF ADMIRALTY METAL IN 3% SODIUM CHLORIDE SOLUTIONS



Duronze III Adds Dependability to D.C. Brake Adjustment Parts

With increased knowledge resulting from experience in the manufacture of equipment, much of which is designed for automatic operation, designers find it necessary to constantly change metal specifications to meet higher engineering demands. Materials long considered satisfactory are being discarded for newer materials which possess superior properties. Engineers want dependability, freedom from rusting, ease of operation, reduced maintenance and longer service life. The modern trend, therefore, is to subject every component part to a searching examination, to eliminate hidden weaknesses. By eradicating the "weak link," so to speak, products are given a longer lease on life.



View of D. C. Shoe Brake showing DURONZE brake adjustment screw at top and DURONZE torque adjustment screw at right.

The D.C. shoe brakes manufactured by the Clark Controller Company are designed for crane hoists, general mill auxiliaries and similar applications where it is necessary to stop a D.C. motor quickly and smoothly and to hold the load when the driving motor is de-energized or power fails.

DURONZE III, a silicon aluminum bronze is specified for two critical parts of these brakes—the adjustment screw for lining wear and air gap, and the torque adjustment screw.

DURONZE III is admirably suited to these exacting tasks because of its combination of engineering properties... high strength (85,000 psi in the annealed condition, 90,000 psi as a hot forging); exceptional corrosion resistance; good wear resistance; low coefficient of friction when in slow moving contact with most other metals and alloys. From the manufacturer's standpoint this alloy is desirable because it hot forges readily and machines from 50 percent to 75 percent as fast as free cutting brass rod.

DURONZE III and the other Bridgeport engineering alloys furnish an opportunity for alert design engineers to improve their metal specifications and thus make their products better. Write for Bridgeport's revised Duronze Manual—80 pages of the latest specifications and other data with suggested applications for five Duronze engineering alloys.

NEW DEVELOPMENTS

This column lists items manufactured or developed by many different sources. None of these items has been tested or is endorsed by the Bridgeport Brass Company. We will gladly refer readers to the manufacturer or other sources for further information.

Metal Pouring Control for pouring operations in foundries is provided by a photoelectric control, it is claimed. A single operator at a remote station can control pouring of several ladles simultaneously by pushing a button on the control. **No. 619**

A Portable Pyrometer weighing only 1¾ lbs. is claimed particularly adapted to reading the temperature of molten copper, brass, bronze, and other copper alloys and non-ferrous metals. Accurate readings can also be taken of hot air, liquids, and hot surfaces. **No. 620**

A New Chucking Grinder is designed to handle external and internal cylindrical and conical surfaces, generated or formed spherical external and internal surfaces and generated or formed annular surfaces. The construction is said to incorporate features that result in accurate finish and low production costs. **No. 621**

A Surface Grinder incorporating a new "five-in-one" hydraulic control valve is reported to provide increased speed, efficiency, simplicity of operation and greater accuracy. Crossfeed action can be controlled in infinite settings for 0.004 to 0.200 depending on the work. The simplified controls are claimed to measurably improve finishing operations. **No. 622**

A White Finish designed to be electroplated directly over brass, copper, German silver, nickel and ferrous metals is claimed to impart the beauty and durability of a precious metal finish. Only equipment required is a steel tank which serves both for the plating bath and as the anode. Average plating time for decorative finishes is one minute. It is claimed soldering and welding can be performed on this finish. **No. 623**

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Executive Offices: BRIDGEPORT 2, CONN.—Branch Offices and Warehouses in Principal Cities

SHEETS, ROLLS, STRIPS—*Brass, bronze, copper, Duronze,* for stamping, deep drawing, forming and spinning.

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PHONO-ELECTRIC* ALLOYS—High-strength bronze trolley, messenger wire and cable.

WELDING ROD—For repairing cast iron and steel, fabricating silicon bronze tanks.

LEDRITE* ROD—For making automatic screw machine products.

"Bridgeport" BRASS

Established 1865

BRASS, BRONZE, DURONZE WIRE—For cap and machine screws, wood screws, rivets, bolts, nuts.

DURONZE ALLOYS—High-strength silicon bronzes for corrosion-resistant connectors, marine hardware: *hot rolled sheets* for tanks, boilers, heaters, flues, ducts, flashings.

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FABRICATING SERVICE DEPT.—Engineering staff.

BRASS AND COPPER PIPE

Note: Bridgeport products are supplied in accordance with existing priority regulations.

*Trade name.

BRIDGEPORT BRASS

you've heard the rumors . . .

Dow gives you the facts on Polystyrene supply

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DOW CHEMICAL COMPANY MIDLAND MICH=

REURTEL RAW MATERIAL SUPPLIES FLUCTUATE MONTHLY AND THEREFORE WE CANNOT PREDICT FUTURE POLYSTYRENE AVAILABILITY FOR CIVILIAN USES=
GEO H SOLLENBERGER WPB CHEMICALS.

THE COMPANY WILL APPRECIATE SUGGESTIONS FROM ITS PATRONS CONCERNING ITS SERVICE

Contrary to many rumors, polystyrene is *not* freely available. We wish it were. Apparently you do too.

WPB is working with every polystyrene producer and supplier to make the most material available to *everyone* as soon as possible. But military needs—which still come first—must be balanced against supply of benzene and production capacity.

These factors are uncertain, changing—one thing today, different tomorrow. As the Nation's largest producer of polystyrene, we'd like to be more specific—but obviously can't. You can be sure that we're doing everything possible to meet your needs and anticipate your growing demands: spreading the benefits of *every available pound of polystyrene* to help keep the nation's employment at the highest level.

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don't put your molder on the spot

When you talk to your molder about polystyrene —REMEMBER—war still creates shortages beyond his control. He's working with us—and will be ready to serve your full *peacetime* needs at the earliest possible moment. "Let's Work It Out Together!"

STYRON

(DOW POLYSTYRENE)

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Rockrite rolled tubing

brings big benefits to

MANAGEMENT EXECUTIVES

PRODUCT DESIGNERS

PRODUCTION EXECUTIVES

SALES MANAGERS

ULTIMATE USERS

THE ROCKRITE PROCESS of sizing seamless tubing differs radically from the customary cold-draw method. This new process is a combination of compression, cold forging and extrusion that sizes tubing more accurately — with greater concentricity and less ovality, and to tolerances that are half or less than half those of ordinary cold-sized tubing. Rockrite Tubing is supplied in straight and tapered styles in ferrous, nonferrous and telescoped bi-metal combinations.

THE MANAGEMENT EXECUTIVE secures savings in manufacturing costs, speedier deliveries, product improvement. For parts can be made from Rockrite Rolled Tubing at high cutting speeds, can often be finished inside and out with one-operation forming tools—sometimes without machining.

THE PRODUCT DESIGNER finds a material of new, revolutionary possibilities for short-cut production of accurate cylindrical or ring-shaped parts—sleeves, ferrules, bearing races, bushings, spacers, etc.—in a variety of metals and bi-metal combinations.

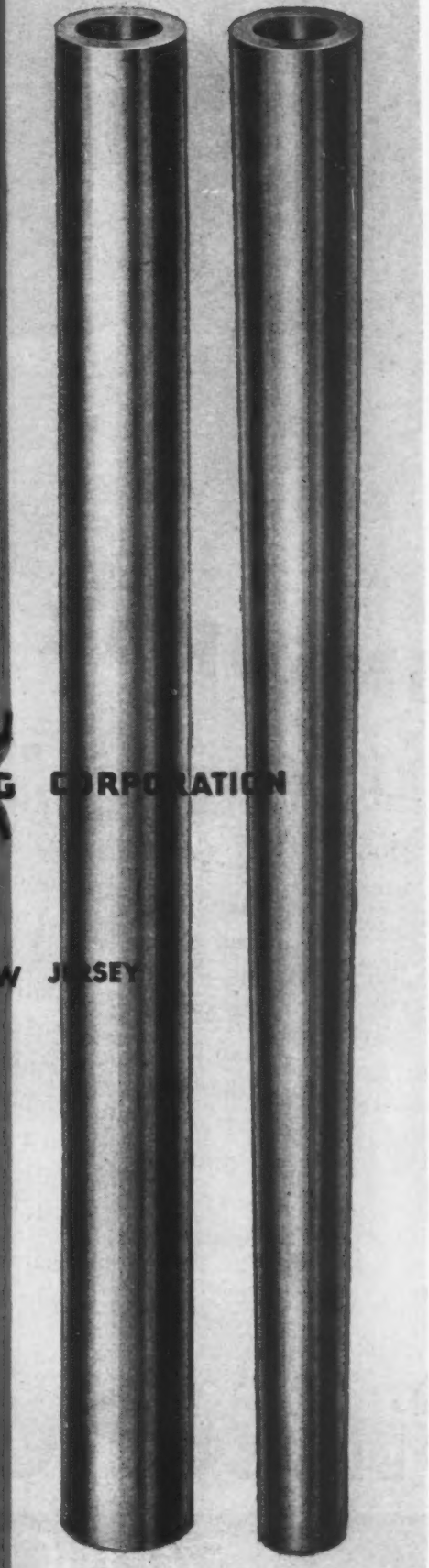
THE PRODUCTION EXECUTIVE gets new operating economies, greater output per machine, reduction in number of operations required and fewer rejections.

THE SALES MANAGER has a product that looks better, performs better, sells better—a completely modern product that can outdistance competition on merit—plus lower price.

THE ULTIMATE USER benefits by getting equipment of precision quality, up-to-the-minute design and manufacture, and definitely better value for his money.

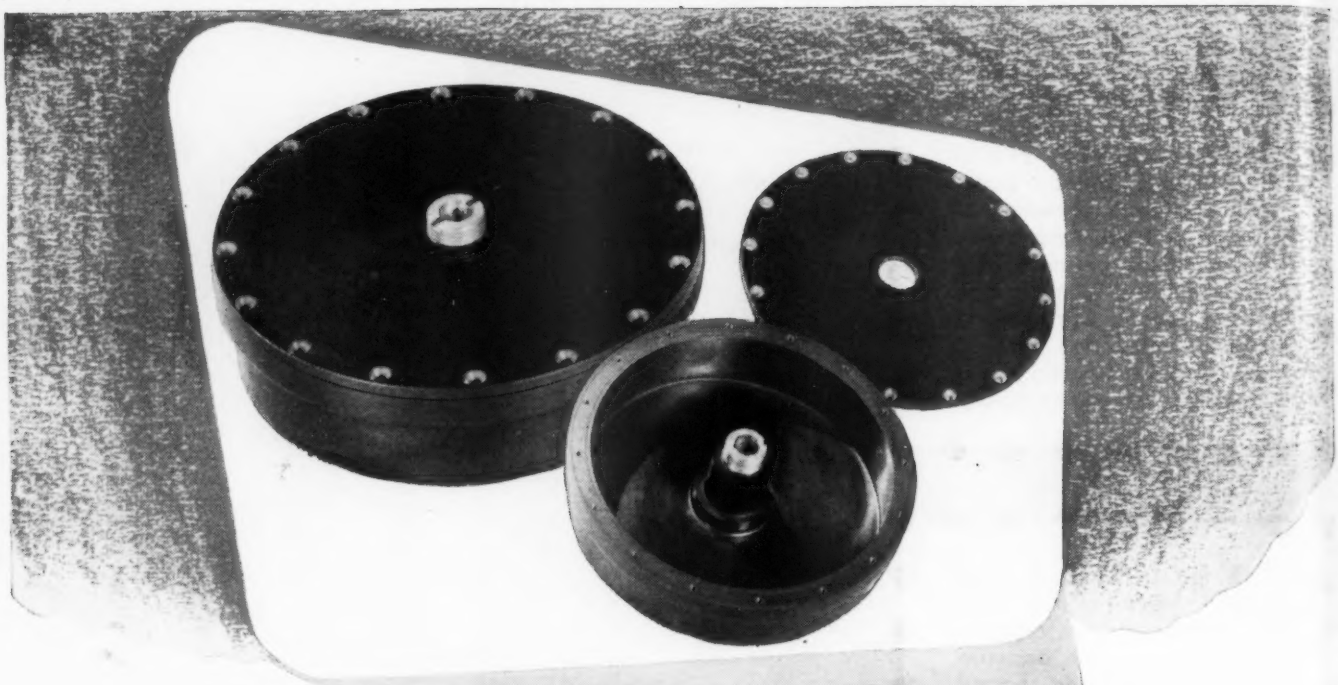
TUBE REDUCING CORPORATION

WALLINGTON, NEW JERSEY



VALUABLE, TIMELY DATA

Send for our 20-page book of vital information on seamless tubing. Tables give accurate comparison of conventional tubing tolerances with those of Rockrite Rolled Tubing. Full description of Rockrite process. Invaluable for product designers, production men, sales managers. Write for your free copy of "Rockrite Close Tolerance Tubing".



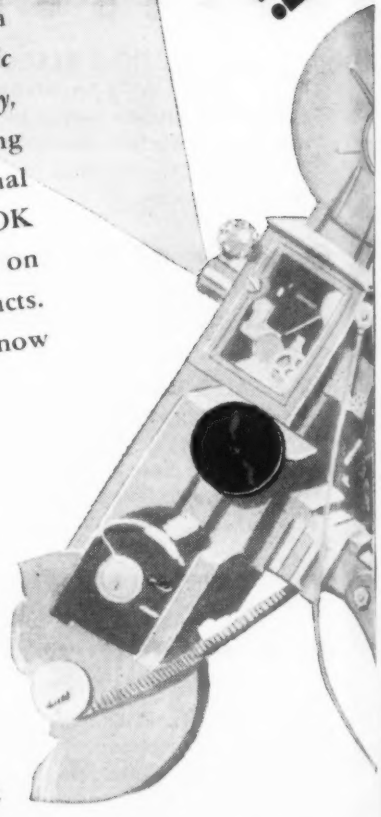
INSUROK cuts costs way down!

—for Motiograph of Chicago!

Motiograph saves at least $2.50 every time they make a rotary stabilizer for the sound head of a motion picture projector—thanks to the use of INSUROK—recommended by Richardson Plasticians. Stabilizer housings are made of Molded INSUROK; the covers, of Laminated INSUROK. The combination holds a flywheel which operates in a special liquid to reduce film flutter and prevent annoying tone distortion.

This outstanding industrial application is typical of the way in which INSUROK Precision Plastics—with their *high mechanical and dielectric strength, lightness, easy workability, and smooth, shiny finish*—are meeting exacting requirements with unusual economy and efficiency. INSUROK is ready to go to work for you on your present or postwar products. Write Richardson Plasticians now for complete information.

Shown Above: Complete Rotary Stabilizer unit, with Molded INSUROK housing—metal insert—and Laminated INSUROK cover. Used by Motiograph, Chicago, Ill.



INSUROK *Precision Plastics*

The RICHARDSON COMPANY

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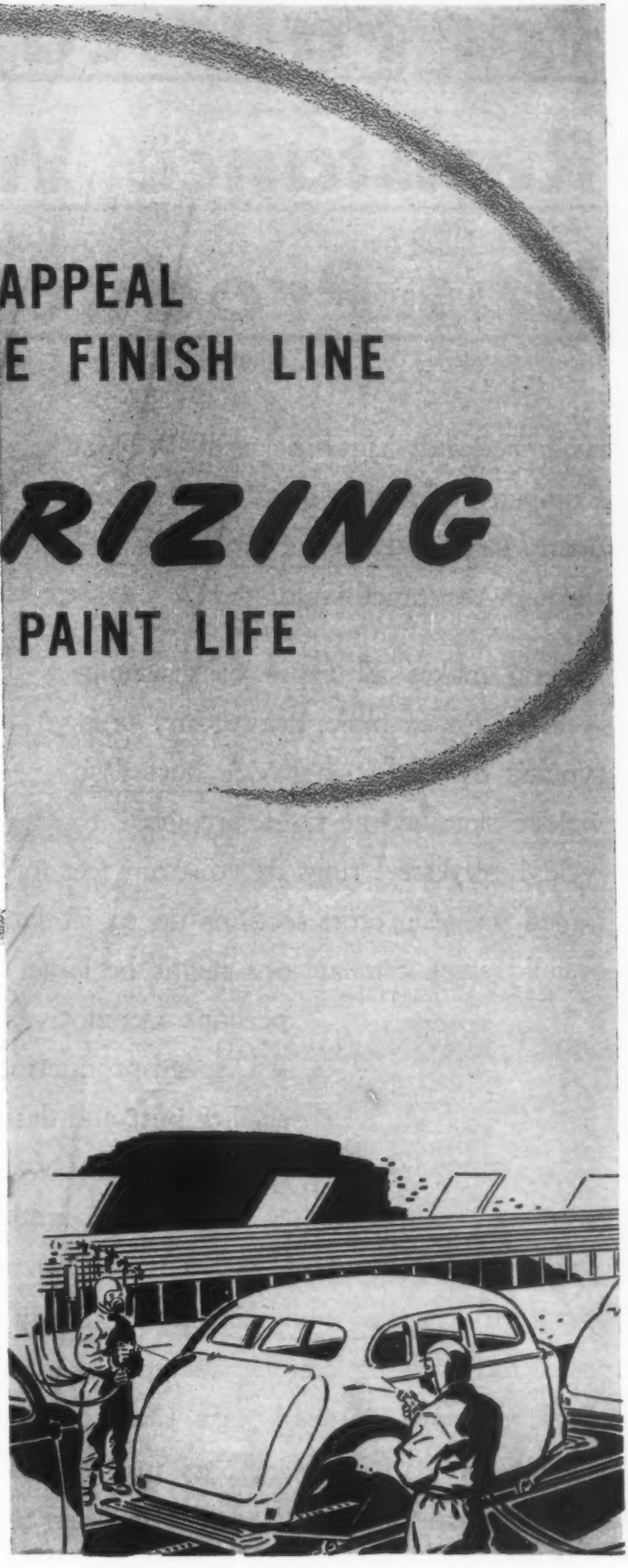
SALES APPEAL STARTS ON THE FINISH LINE

BONDERIZING

INCREASES PAINT LIFE



Favorable selling impressions start with fine product appearance. When the salesman can say that Bonderizing assures up to five times greater endurance for the finish, it becomes a powerful sales influence.

Sales appeal starts on the finish line. Bonderizing creates a surface that *bonds* paint to the metal; assures enduring beauty, and provides resistance to the spread of rust from accidental abrasion.

The finish stability obtained by Bonderizing means extra value and quality and extra sales appeal for your product.

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BONDERIZING HOLDS PAINT TO STEEL

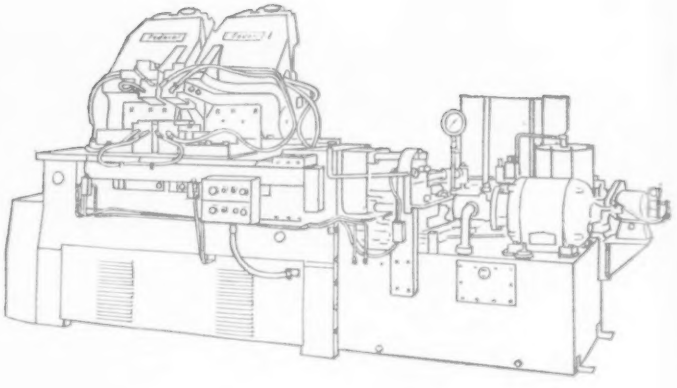
PARKERIZING INHIBITS RUST

PARCO LUBRIZING RETARDS WEAR

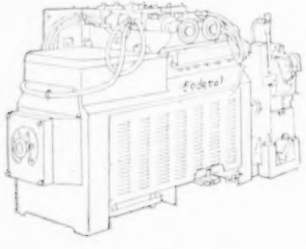
PARKER PRODUCTS CONQUER RUST

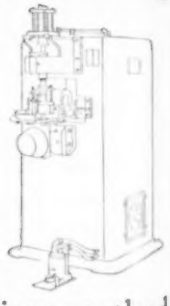
For Fabrication of Meta
Resistance Welding Downs
Ups Production . . .

The Federal Machine and Welder Company offers the metal working industry increased efficiency in production through resistance welding.



Federal makes all types of resistance welders: for example, heavy duty units typified by the 1000 KVA butt flash welder sketched at right, are made to weld heavy steel rings up to seven feet in diameter. These welders produce high quality forged welds in cross sections up to 18 square inches of high carbon steel, greater areas of mild steel. Similar jobs might be large ring gear blanks, rotating platform bearings, perhaps locomotive tires . . . Sash welders, such as sketched at left, speed production on steel sash of all kinds, are typical of the smaller butt and flash welders adaptable to everything from table knives (stainless welded to mild steel) and tools (high carbons to mild), to all kinds of metal tubing, rods and strips (including copper to aluminum in special instances), with either automatic or hand operation . . . Press type welders, amazingly versatile units for all kinds of projection welding, can be adapted by die changes to an infinite variety of fast assembly of metal parts. One suggested in the right hand corner of this page welds handles to pots and pans of enameling steel (adaptable for aluminum) and in actual production has cut costs to one-fifth that of previous method . . . And, speaking of versatility, one of the most useful tools in metal fabrication is the

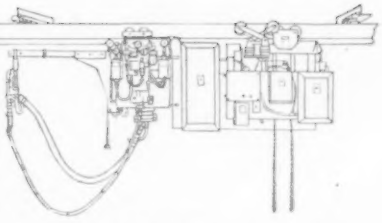




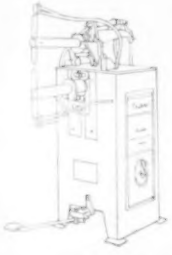
THE FEDERAL MACHINE AND W

to Metal,

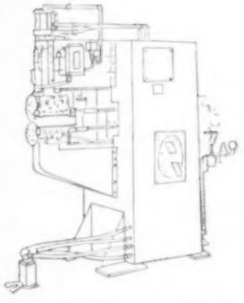
Costs . . .



gun type resistance welder, an example of which is the overhead rail unit which can be rolled up and down an assembly line and allows operator a wide radius of travel about the work (see above) . . . Spot welders, from small utility rocker arm types (see left) to heavy duty units capable of welding sheets up to ⅜ inch each have wide use in the metal working industry . . . Roll spot and seam welders have equally broad application, produce a continuous or intermittent weld, automatically indexed . . . and many other cost saving types.



Federal wants to make available to you full information on applications of resistance welding to better and faster fabrication. We want to bring you up to date on resistance welding as a tool for modern production. Federal is ready to help if you will tell us WHAT YOU WANT TO KNOW ABOUT RESISTANCE WELDING.



Consult "the name of authority on resistance welding".

Federal

WELDER CO. 232 Dana Street WARREN, OHIO

VERSATILE MODERN PRODUCTION TOOLS

BARREL WELDERS

Of the millions of welded steel drums or barrels used to distribute gasoline and oil to our mechanized war in far corners of the earth, a vast majority are welded on Federal Barrel Welders. Not only has a major percentage of the industry for many years been equipped with Federals, but The Federal Machine and Welder Company designed and built several complete barrel manufacturing plants set up by the army at distant bases to augment the tremendously increased output of the home industry.

Seam welds (resistance welded) in such containers must be able to take terrific punishment. Immediately after welding, the barrel shells pass through a machine which forms two rolling rings in the side, by stretching the steel outwardly under great pressure. Then, too, the loaded barrels, weighing over four hundred pounds, often are dropped a distance that subjects them to thousands of pounds impact. The weld must hold.

NEW FOLDERS

Most recent informative bulletins on Federal Resistance Welders to come from the press are the new "Type R" bulletin describing a complete line of rocker arm utility spot welders . . . and "Type P" Bulletin with details of Federal's Press Welders, used for projection welding, mash welding, etc. Bulletins are available now on request.

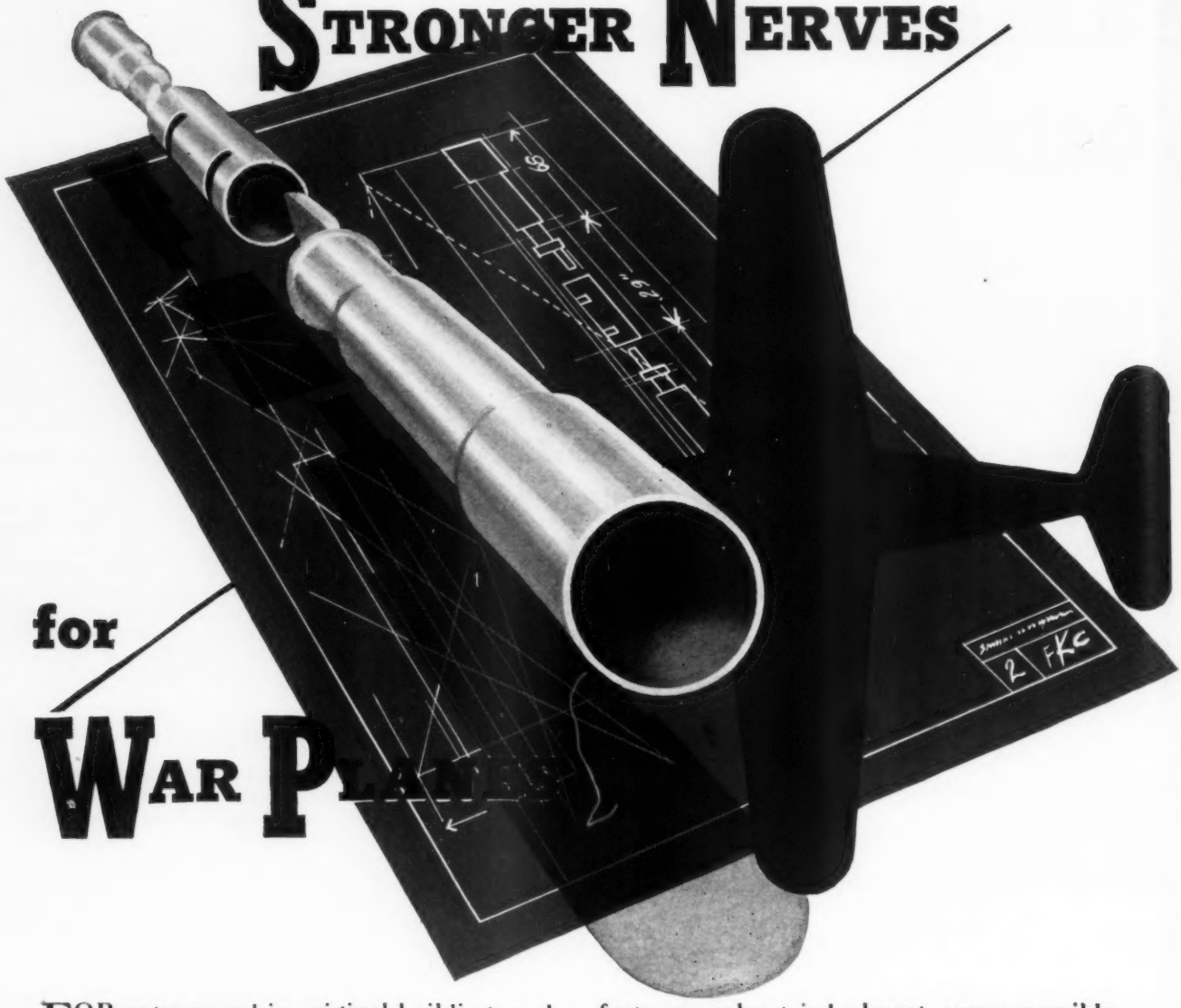
HOUSEWARE PRODUCTION

Anticipated expansion of houseware production points up the advantages of Federal resistance welding for the fast, low cost application of handles to enameling steel or aluminum pots and pans. Press type welders are used, with dies that permit rapid loading, give production of 500 to 800 handles per hour, depending upon type of handle applied. Cost with one manufacturer is one-fifth previous methods.

INTERESTING PLANT

Full details of a complete manufacturing plant for high production of large resistance welded tank turret rings (up to seven feet OD) are in a book just released by The Federal Machine and Welder Company. The company designed and built the entire plant, shipped to a foreign power. Point of interest is that similar rings, which can be made with same equipment, could be used for large ring gear blanks, rotating table bearings, possibly locomotive tires. Limited number available to executives, technical men, sufficiently interested to write to Federal giving name, official title and company name.

STRONGER NERVES for WAR PLANES



FOR extra speed in original building, and in making heat-of-battle repairs, current carrying wires—the nerves of war planes—are held together by pressure (solderless) fittings. These small fittings consist of two tips connected by a spring sleeve coupler.

The coupler shoulders two responsibilities. It presses the faces of the tips firmly together to maintain good electrical contact and also prevents the tips from unintentionally parting company. Spring tension without let-up is vitally important. The manufacturer, who tried almost every possible material for the coupler, settled finally upon Riverside *Beryllium Copper*. Interestingly enough, his choice was influenced not only by the favorable characteristics of Riverside *Beryllium Copper* but by realistic considerations of quality and delivery.

Our attention to quality and delivery is, in fact, second only to our interest in helping you benefit from the use of our alloys—*phosphor bronze, nickel silver, and beryllium copper.*

INSIDE RIVERSIDE—*In the hurry and rush of war times, many of us have forgotten the existence of a very important word—courtesy . . . How often we meet up with people who do not even attempt to give courteous treatment to those whom they are supposed to serve . . . We, at Riverside, try to avoid this pitfall. We make an extra effort to see that all of our customers—regardless of their size, or of the difficulty of their demands upon us—are given every courtesy and attention.*

RIVERSIDE

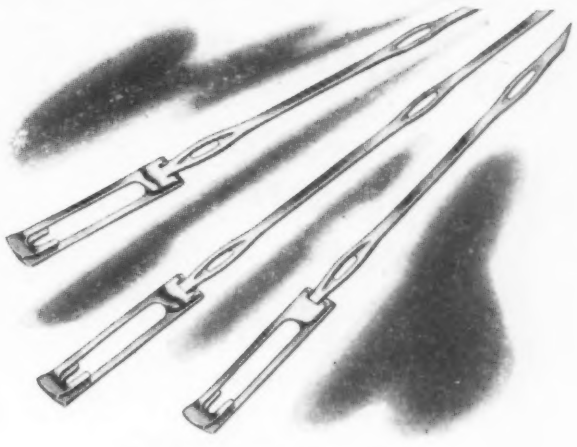
RIVERSIDE METAL COMPANY

NEW YORK · CHICAGO · RIVERSIDE • NEW JERSEY · HARTFORD · CLEVELAND

RIVERSIDE PHOSPHOR BRONZE ALLOYS — Copper-tin alloys to which phosphorus is added. Made in variety of wrought and malleable alloys; special leaded mixtures; in non-malleable cast and turned rods for bearings and bushings. PROPERTIES—Wide range of tensile strengths and hardnesses. In general, phosphor bronze is a good electrical conductor, non-magnetic, and has a low coefficient of friction. It is easy to machine, can be welded by carbon or metal arc (there's a special alloy for flame welding), can be brazed or soldered. Easy to punch, draw, stamp, or spin. Phosphor bronze is rustless and resistant to corrosion, fatigue and wear. Supplied in sheets, strips, wire, rods, circles, bars, blanks or ingots.

Typical use: Rifle nut for Jackhammer

RIVERSIDE NICKEL SILVER ALLOYS — A combination of copper, nickel and zinc in various proportions. Made in variety of alloys, tempers, anneals; and in free-cutting alloys. PROPERTIES—Vary according to alloys. Tensile strengths up to 160,000 p.s.i., elongations up to 50%. Nickel silver is valued electrically for its specific resistance, and physically because of its clear-through silvery white appearance. In general, it is tough, resistant to wear, fatigue, and corrosion. Easy to machine in any manner, weldable by *all* methods, can be brazed or soldered and is extremely workable. Readily formed, bent, drawn, stamped, punched, embossed or spun. Supplied in sheets, strips, wire, rods, circles, bars, blanks and ingots.



Typical use: Repair heddle for loom

RIVERSIDE BERYLLIUM COPPER — an alloy with an unusual combination of properties — Unusually high strength. Excellent hardness, wear resistance and corrosion resistance. High thermal conductivity, good electrical conductivity. Easy to braze, solder, punch, draw or stamp. Can be cold worked. Outstanding for hot working qualities. Can be easily hot forged or hot pressed between 1050° and 1425°F., and heat hardened to achieve strengths rare to non-ferrous metals and alloys. Great resistance to fatigue under action, which is pronounced at high temperatures where other non-ferrous materials might fail. Negligible creep or hysterisis. Non-magnetic qualities. Supplied in sheets, strips, wire, rods, bars and blanks, usually, semi-hard, cold worked for fabrication and heat treatment.

Typical use: Hose clamp

...special alloys of copper, zinc, and tin for specific purposes

PHOSPHOR BRONZE
NICKEL SILVER
BERYLLIUM COPPER

It's Sensational! . . . Here is the *NEW,*

BONDS ANYTHING

IT'S STRONG
•
IT'S PERMANENT
•
WITHSTANDS CONSTANT FLEXING
•
APPLIES EASILY (one part adhesive)
•
SETS QUICKLY
•
IMMUNE TO FUNGI
•
RESISTS WATER, OILS AND WAX
•
WORKS HOT OR COLD

UNITED STATES PLYWOOD CORPORATION, 55 West 44th Street, New York 18, N. Y.

Please send me a free sample of PLIOBOND.

Name_____ Title_____

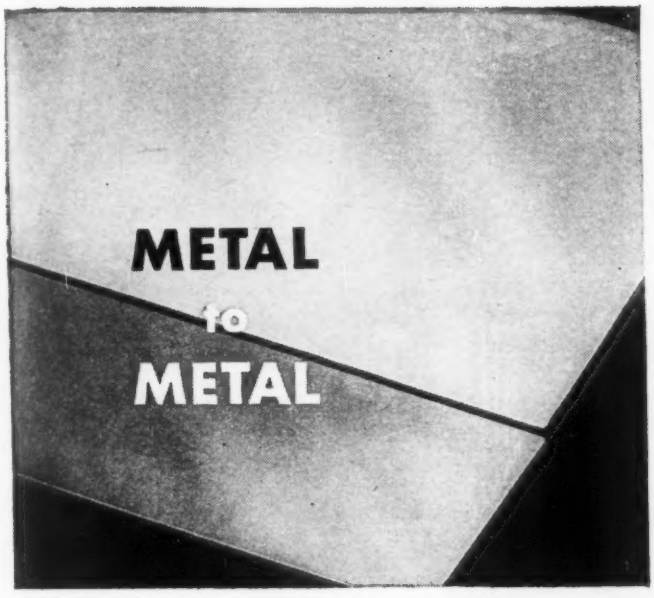
Firm_____ Address_____

P.E.-7-45

TRY A SAMPLE IN YOUR OWN WORK

Quick-Setting Plastic Adhesive that

TO ANYTHING!



Pliobond

—FOR IMPROVED PRODUCTION TECHNIQUES

Pliobond is one of American industry's great wartime achievements, now solving scores of production problems.

An all-purpose plastic adhesive that *simply* and *easily* bonds materials together which have never before been bonded successfully.

Pliobond joins any materials . . . like or unlike . . . metals, plastics, fabrics, glass, rubber, wood, ceramics, paper, leather, plaster, concrete, etc. For most applications, no high pressure or heat is needed. In others, where extremely high shear strength is desired, moderate pressure and 200 – 300° F. will produce a perfect bond.

When you use Pliobond, there's no elaborate procedure involved. It's a *one*-part bonding agent . . . always ready to go to work. No fussy mixtures. No careful weighing. No critical temperatures. It can be brushed, sprayed, spread or roller coated.

Manufacturing facilities for Pliobond are rapidly being increased to meet all demands. For sample and technical information, please use coupon, writing us in detail on any special problems.

UNITED STATES PLYWOOD CORPORATION *EXCLUSIVE DISTRIBUTORS*

Industrial Adhesives Division: 55 West 44th Street, New York . . . Branches in principal cities

***Pliobond* is a product of* THE GOODYEAR TIRE & RUBBER COMPANY**

*Trademark registered, The Goodyear Tire & Rubber Company

STRENGTH · BEAUTY · PERFORMANCE

The slick plane zooming in the sky . . . the streamliner roaring through the night . . . are perfect examples of BEAUTY OF DESIGN, SMOOTH PERFORMANCE, RUGGEDNESS, all qualities you want in your product. Careful planning NOW is the order of the day.

New Products Corporation and Modern Plastics Corporation are well qualified to help you to make your products more serviceable and more saleable. Consult either of these firms for an impartial, practical analysis of your product design and assistance in its manufacture.

Two Independent Organizations Dedicated to Your Product Development

NPC NEW PRODUCTS Corporation

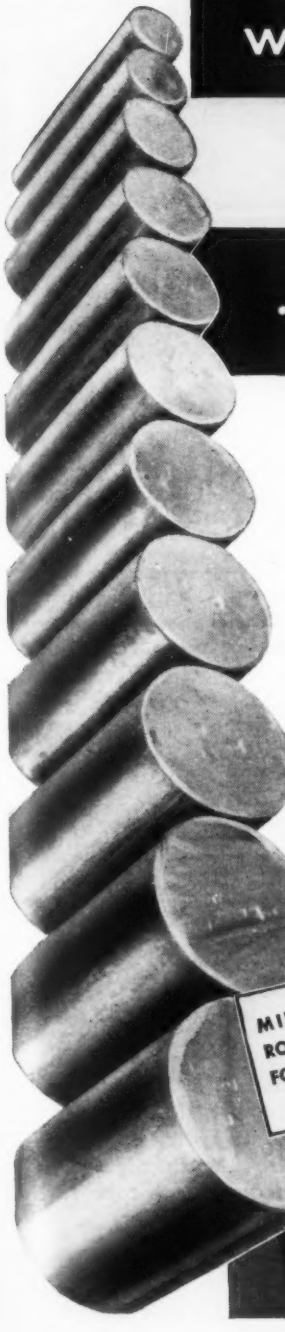
CONTINUOUS CAST VS. SAND CAST

Important Production Economies

with Bearing Bronzes in This New Form

No costly scrap — faster production on screw machines

..with Ampcoloy { continuous cast bronze rods



For the first time, certain bronze alloys — previously available only as sand, permanent mold, or centrifugal castings — are now produced in 10 foot lengths by a continuous casting process, exclusive with Ampco in the cast bronze field.

The comparative photomicrographs (tin bronze) illustrate the tremendous improvement in quality. Also the materials are adaptable to fabrication on automatic screw machines, with big savings in time, manpower, and money. Sand-free surface — no internal segregation — uniform diameter and even length. Scrap loss due to metal faults practically eliminated.

Also available are high-lead bronze and other bearing bronzes. Immediate shipment on rods up to 2" in diameter. Tubes available for prompt shipment, in tin bronze only.

Write for data sheet 131. *Ampco Metal, Inc., Dept. PE-7, Milwaukee 4, Wis. Ampco field offices in principal cities.*

Reg. U. S. Pat. Off.

AMPCO

Ampcoloys are a product of

Ampco Metal, Inc.

. . . specialists in engineering, production, finishing of copper-base alloy parts.

Tear off coupon and mail today

AW-14

AMPCO METAL, INC.
Dept. PE-7, Milwaukee 4, Wis.

Please send my copy of data sheet 131.

Name.....

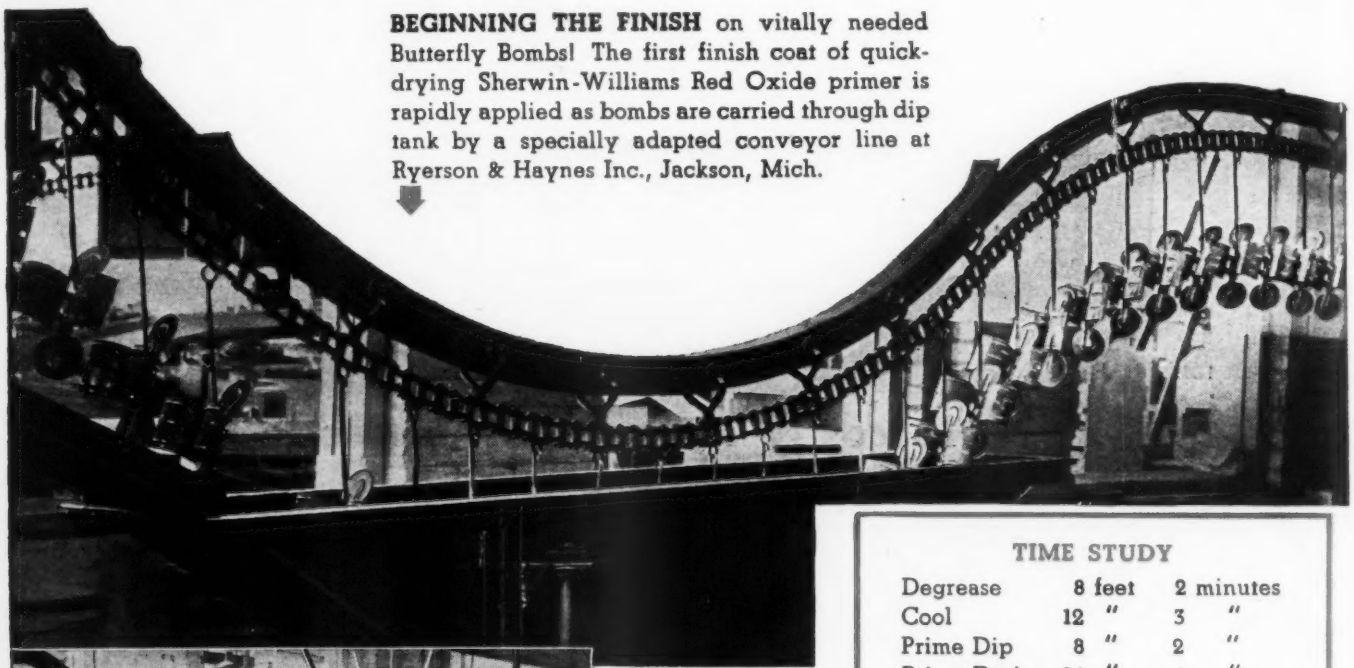
Position.....

Company.....

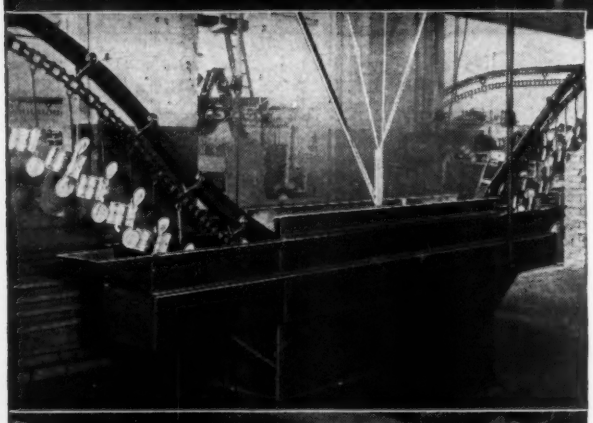
Address..... ☐ Home ☐ Office

City.....(....) State.....

FLUTTERING OUT



BEGINNING THE FINISH on vitally needed Butterfly Bombs! The first finish coat of quick-drying Sherwin-Williams Red Oxide primer is rapidly applied as bombs are carried through dip tank by a specially adapted conveyor line at Ryerson & Haynes Inc., Jackson, Mich.



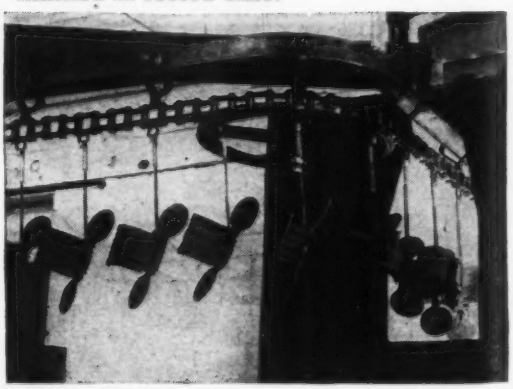
DEGREASING "BUTTERFLIES" in a tank of solvent prepares bombs for the first finish coat. Moving on an automatic conveyor line, bombs are untouched by hands throughout entire finishing operation!

PRIMARY ASSEMBLY of Butterfly Bombs is made from pre-stamped metal parts by capable girls. Next step is riveting operation that completes assembly of "Butterfly" with just four rivets!

TIME STUDY

Degrease	8 feet		2 minutes	
Cool	12	"	3	"
Prime Dip	8	"	2	"
Prime Drain	24	"	6	"
Prime Bake	8	"	2	" (Infra-red)
Prime Cool	16	"	4	"
O. D. Dip	8	"	2	"
O. D. Drain	20	"	5	"
O. D. Bake	12	"	3	" (Infra-red)
Cool	64	"	16	"
	180 feet		45 minutes	

TIME TABLE of finishing operation reveals, step by step, how Butterfly Bombs are finished in record time!



WELL DONE! Baking in 5-foot infra-red oven quickly dries the first primer finish coat. "Butterflies" cool while moving 25 feet on conveyor line, are ready for the final finish.

SHERWIN-WILLIAMS

THE *Butterflies*

STINGING THE JAPS! Fluttering from planes, deadly Butterfly bombs scatter fragments 50 feet in all directions upon slightest contact with any object—are invaluable in wiping out enemy positions in inaccessible locations.

SHERWIN-WILLIAMS helps RYERSON & HAYNES INC. SPEED OUTPUT OF DEADLY BUTTERFLY BOMBS

Vitally needed on all fronts, Butterfly Bombs are being delivered by the thousands every day for the Ammunition Branch, Detroit Ordnance District, U. S. Army Service Forces by Ryerson & Haynes Inc., Jackson, Michigan.

This successful job depends on speed in the finishing operation. To solve this problem, Sherwin-Williams technicians helped Ryerson & Haynes engineers develop a conveyor line that dips, bakes, and dries the bombs in one continuous, synchronized operation.

Two fast-drying Sherwin-Williams finishes make possible the split-second timing needed to keep the conveyor line in motion. After Sherwin-Williams Red Oxide primer is applied, the bombs are baked in an infra-red oven, cooled, then passed on to the final finish of S-W Olive Drab Lustreless Enamel. More baking and they're ready for War . . . in record time!

Perhaps we can help you, too! Write The Sherwin-Williams Co., Industrial Finish Dept., Cleveland 1, Ohio.

INDUSTRIAL FINISHES

HERE'S LIGHT WEIGHT AND STABILITY...

FOR many mechanical and structural uses, Formica is the chosen material because of its light weight, strength, and a remarkable ability to remain unchanged under a variety of conditions.

Moisture absorption is low, and that contributes to great dimensional stability under varied conditions of humidity. The coefficient of thermal expansion is also very much lower than that of metals and that also tends to hold the original dimensions. The material possesses a high degree of chemical inertness which prevents corrosion and maintains the surface finish under a wide range of conditions.

In wearing parts the material has a tendency to wear smoothly without accumulating a corrugated surface, and that contributes to long life.

Formica engineers have a wealth of information in detail regarding these qualities which they would be glad to pass on to those interested.

FORMICA

THE FORMICA INSULATION CO., 4645 SPRING GROVE AVE., CINCINNATI 32, O.

Here again—
the answer was an *Extruded Shape*

The E. T. Fraim Lock Company of Lancaster, Pa., has a world-wide reputation for the manufacture of high grade locks, built to unusually accurate specifications. When large-scale production of pin tumbler padlocks for the Armed Forces was undertaken recently, a review of design and materials became necessary.

The component parts—pins, tumblers, springs, case, shackle, bolt, plug and keys—all could be produced readily and in adequate quantities . . . that is, all but the brass sleeve with its unusual shape. And there *was* a problem!

Brass castings were being used, requiring machining all over for the intricate assembly. Lack of uniformity, coarse grain structure and surface roughness and irregularities left much to be desired.

The solution was found in the Anaconda Extruded and Drawn Brass Shape illustrated above. Here was wrought metal, smooth of surface and uniformly accurate in cross section. Sleeves could be "sliced" off long mill lengths—and the parts would fit drill jigs and milling fixtures without filing or fussing. Several operations, previously necessary, were entirely eliminated. Rejections were held to a minimum. And as in so many similar instances, the uniform grain structure and high rate of machinability of the extruded part made possible faster, more accurate production, saving time and tools.

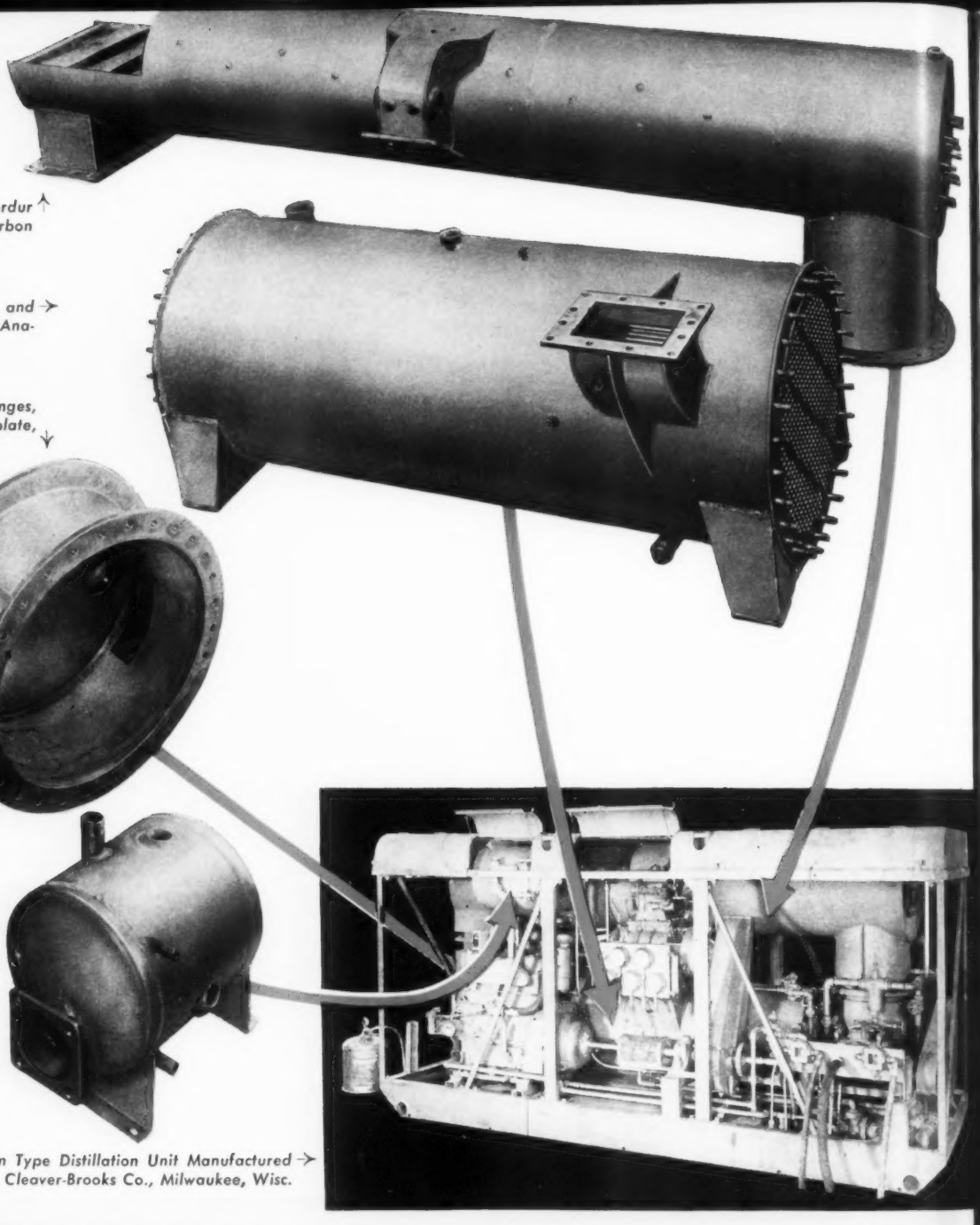
Similar design or production problems may appear in your plant, anywhere from the drawing board to the assembly bench. If they do, remember that our Technical Department will be glad to work with you. 45157

THE AMERICAN BRASS COMPANY

General Offices: Waterbury 88, Connecticut
Subsidiary of Anaconda Copper Mining Company
In Canada: ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*

ANACONDA
from mine to consumer

Anaconda Extruded & Drawn Shapes



Evaporator and flume of Everdur sheet-metal construction, carbon arc welded with Everdur rod.

Condenser: Shell, tube sheets and bolts are Everdur; Tubes are Anaconda Arsenical Admiralty.

Discharge Head, including flanges, made of Everdur sheet and plate, carbon arc welded.

Distillate Boiler: All Everdur, including supports and pipe connections. Carbon arc welded.

Compression Type Distillation Unit Manufactured by Cleaver-Brooks Co., Milwaukee, Wisc.

SO THERE'S WATER TO DRINK FOR OUR FIGHTING MEN...

This "seagoing waterworks" uses *Everdur* for ruggedness and dependability

In amphibious operations, this Cleaver-Brooks Compression Type Distillation Unit is among the first items of equipment to be put ashore. From sea water or jungle swamp it will deliver up to 175 gallons of distilled water an hour—pure water for drinking, cooking and other purposes. Little wonder that Everdur Metal is used so extensively and effectively for these important components. For Everdur* has established an outstanding record for service in waterworks and similar fields. It combines strength and corrosion resistance in economical lightweight, welded, sheet-metal construction.

*Reg.U.S.Pat.Off.

THE AMERICAN BRASS COMPANY

General Offices: Waterbury 88, Connecticut

ANACONDA
from mine to consumer

Everdur Copper-Silicon Alloy

New Catalog and Handbook of Taylor Laminated Plastics

Just off the press! A 54-page catalog and handbook containing the latest factual data, standards, and engineering information on Taylor Phenol Fibre and Vulcanized Fibre sheets, rods, tubes, and fabricated parts. An invaluable reference book for purchasing agents, design engineers, and manufacturers whose products contain laminated plastic parts. The scarcity of paper has forced us to make this a "limited edition," so if you want to be sure of getting a copy before the supply is exhausted, write today on your business letterhead.

TAYLOR FIBRE COMPANY

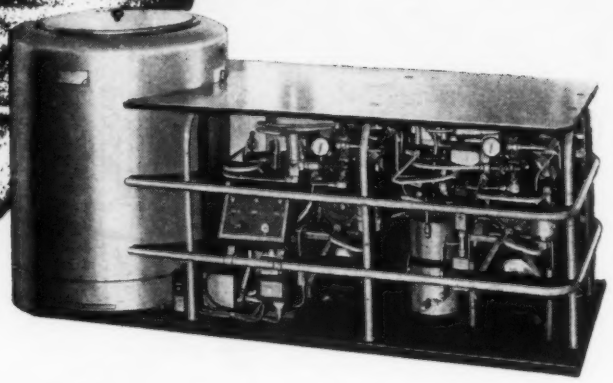
LAMINATED PLASTICS: PHENOL FIBRE · VULCANIZED FIBRE · Sheets, Rods, Tubes, and Fabricated Parts

NORRISTOWN, PENNSYLVANIA · OFFICES IN PRINCIPAL CITIES · PACIFIC COAST HEADQUARTERS: 544 S. SAN PEDRO ST., LOS ANGELES 13

FACTS PROVE

that you need Cold Treating in your plant

Records Submitted by *Deepfreeze* Users Establish Cold Treating as a Time-Saving Aid to Low Cost, Quality Production



OPERATION	PART	PERFORMANCE PRIOR TO COLD TREATMENT	PERFORMANCE FOLLOWING COLD TREATMENT
HARDENING	High Speed Drill	48 holes per grind	256 holes per grind
	Tap	40 pieces per grind	500 pieces per grind
	Milling Cutter	7 hours per grind	24 hours per grind
STABILIZATION	Pump Plunger	Operation unsatisfactory due to metal growth.	Perfect operation indefinitely, due to complete stabilization.
	Gauge Blocks	Blocks expanded and warped.	Blocks held original size and shape.
	Lapping Flats	Resurfacing required every 2 to 3 hours.	Resurfacing required every 2 to 3 days.
SHRINK-FIT	Airplane Landing Struts	20 minutes required for assembly.	10 minutes required for assembly.
	Tapered Roller Bearing Race	½ hour to insert in casting.	½ minute to insert in casting.

These performance records are typical of economies obtained in many of the nation's leading industrial plants by the use of Cold Treating in various production processes—economies which can be duplicated under similar conditions in your plant.

Cold Treating is used to accomplish a variety of purposes—all with equal efficiency and economy. Foremost among these are hardening metals and metal parts; stabilizing precision parts, gauge blocks, lapping flats, etc.; shrinking metal parts for rapid assembly; and testing of instruments and equipment for high altitude, low temperature operation. In addition, Cold Treating is performing a multitude of specialized operations too numerous to mention.

You, Too, Can Profit by Using Cold Treating

Whatever your production, a survey of the outstanding results obtained by applying sub-zero temperatures to industrial operations—a few of which are shown in the panel at left—is convincing proof of the economical value and utility of this newest "tool" for industry. Think what such results can mean to your operations in terms of production economies and improved quality of your product.

Let Deepfreeze Engineering Service Assist in Adapting Cold Treating to Your Production

If you are unfamiliar with industrial Cold Treating or are using it on a limited scale and are interested in increasing its range of utility, contact Deepfreeze Engineering Service. Our experienced refrigerating engineers will make a complete study of your product and production setup and enumerate the possibilities and advantages of applying it on the broadest possible scale. This service will not obligate you in any way.

FREE . . . Complete Cold Treating Information

This new 40-page booklet contains all of the facts necessary for a complete understanding of industrial Cold Treating. It explains in detail what occurs within a metal structure when cold treated; illustrates its many uses and resultant savings in time and money; lists up-to-date Cold Treating procedures, gives the names of manufacturers using Deepfreeze equipment; and numerous additional data which you need in applying it to your production. Write today for your copy of Bulletin No. I-4.

Deepfreeze

2326-7 DAVIS STREET, NORTH CHICAGO, ILLINOIS

EYE for QUALITY

Last Time, Too!

Back in 1918, although courageous pilots sometimes joked that "their crates held together with baling wire and a prayer," our planes were relatively good. Even then, OSTUCO Seamless Steel Tubing was beginning to count as a *quality* factor in aircraft construction. Since that time —yes, since Pearl Harbor—the story of aircraft design development is one of tremendous, "impossible" achievements. OSTUCO's part in this engineering saga is indicated by this fact: OSTUCO Seamless Steel Tubing is now used in every type of plane in the air.

Equally important is OSTUCO's delivery record. "When we've needed material on short notice . . . you have always come through with the impossible," says one famous plane builder. Such comment is typical, and in an industry whose race against time has been phenomenal.

The aircraft industry is one of many in which OSTUCO quality is essential to product strength, performance or service—in which OSTUCO's delivery promptness is vital to production schedules. Back of this record is an ever-vigilant "eye for quality," typified in the photo above by the metallurgical microscope test which minutely checks the steel billet as received. There are many such strict controls throughout OSTUCO's production cycle. This is something to remember in your product planning. Why not call your nearest OSTUCO sales office now and discuss your anticipated problems?

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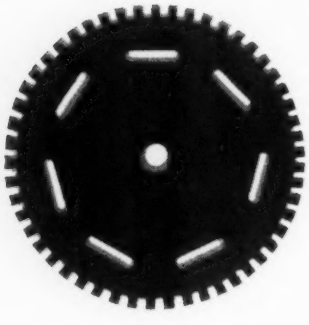
Plant and Main Office • SHELBY, OHIO

MANUFACTURERS OF SEAMLESS AND ELECTRIC WELD STEEL TUBING

SHELBY OSTUCO OHIO

Perfect shapes for your new products



MASONITE

REG. U. S. PAT. OFF.

BRAND PRODUCTS

*"Masonite" is a trade-mark registered in the U. S. Pat. Off. and signifies that Masonite Corporation is the source of the product.

● SIMPLIFY FABRICATION WITH MASONITE PRESDWOODS

Precision parts produced inexpensively on a production basis—that's one of the advantages of designing your new products to utilize Masonite* Presdwoods. These extraordinary hardboards, ligno-cellulose products of exploded wood fiber, can be die-cut, punched, drilled, routed and shaped to precise dimensions—or worked with ordinary wood-working tools! They take permanent bends, laminate efficiently with numerous other materials.

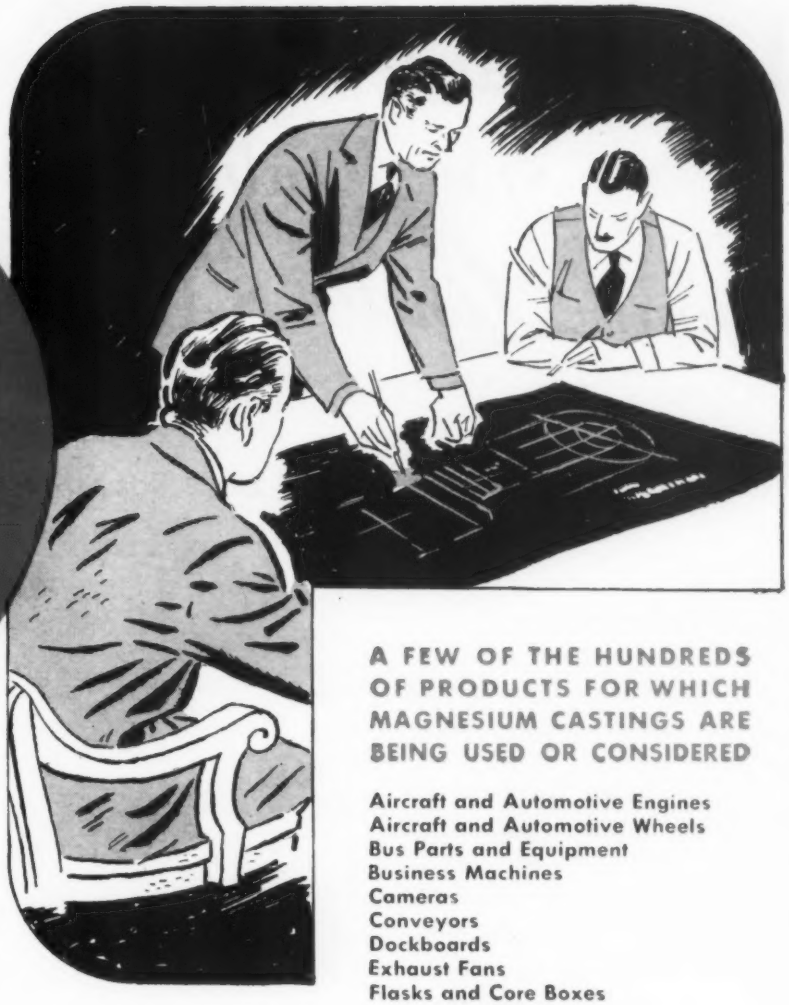
No other basic material embodies the same combination of structural characteristics, takes so many kinds of finish so well . . . or offers the same opportunity to improve appearance, usefulness and quality and to simplify construction.

Write for the "Designers' Manual" that outlines the physical qualities of the Presdwoods. Let our engineers consult with you in working out design or manufacturing plans. Masonite Corporation, Dept. PE-7, 111 West Washington Street, Chicago 2, Illinois.

Wellman

ALUMINUM, MAGNESIUM OR BRONZE

SAND CASTINGS



FOR IMPROVED DESIGN OF YOUR FUTURE PRODUCTS

OUTSTANDING among the advantages of Well-Cast Aluminum and Magnesium Alloys is their ability to provide low weight with high strength.

As you discuss the design of new products or the redesign of those you made prewar, investigate the use of Well-Cast light metal castings. Our 35 years' experience in Aluminum and 15 years' experience in Magnesium is available to your engineering department.

Write today for a copy of our new 16-page catalog containing helpful metals data, or ask to have one of our field engineers call if you wish to discuss a specific casting application.

Wellman Means Well-Cast

A FEW OF THE HUNDREDS OF PRODUCTS FOR WHICH MAGNESIUM CASTINGS ARE BEING USED OR CONSIDERED

Aircraft and Automotive Engines
Aircraft and Automotive Wheels
Bus Parts and Equipment
Business Machines
Cameras
Conveyors
Dockboards
Exhaust Fans
Flasks and Core Boxes
Household Appliances
Marine Engines
Office Equipment
Portable Equipment
Portable Tools
Printing Frames
Pulleys
Radios
Railroad Car Parts and Equipment
Sewing Machines
Spools
Textile Machinery
Truck and Trailer Parts
Typewriters

Castings in **ALUMINUM** (HEAT TREATED)
MAGNESIUM • BRONZE
AMPCO BRONZE • BRASS

Patterns in Metal and Wood

THE **WELLMAN** **BRONZE & ALUMINUM COMPANY**
GENERAL OFFICES:
2557 EAST 93rd STREET • CLEVELAND 4, OHIO

CASTINGS X-RAY INSPECTED

Important Facts
you should know
about Linde SAPPHIRE AND RUBY
(*Synthetic Corundum*)

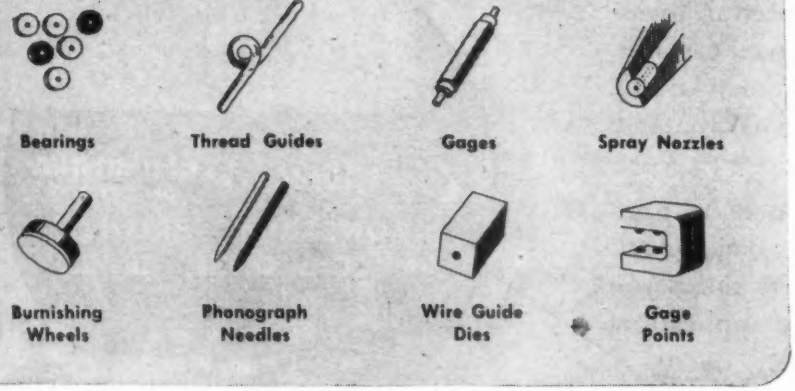
• LINDE Sapphire and Ruby have a unique combination of properties of special interest to machine and product designers in many industries. Composed of single crystals second only to the diamond in mineral hardness, they can be given a surface that is perfectly smooth. Their properties listed at the right, and typical uses listed below, may suggest how you can use these unique man-made gem materials for parts requiring the utmost in hardness and wear resistance.

The word "Linde" is a trade-mark of the Linde Air Products Company.

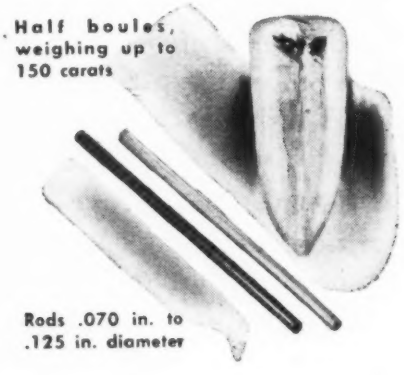
LINDE Sapphire and Ruby Have These Qualities

Melting Point	2,050 deg. C.
Hardness, Mohs' Mineral Scale	9.
Tensile Strength	65,000 lb. per sq. in.
Elastic Modulus	60,000,000 lb. per sq. in.
Chemical Resistance	Excellent
Thermal Conductivity	Low
Electrical Conductivity	Low

Some Ways in Which They Are Used . . .



How They Are Supplied

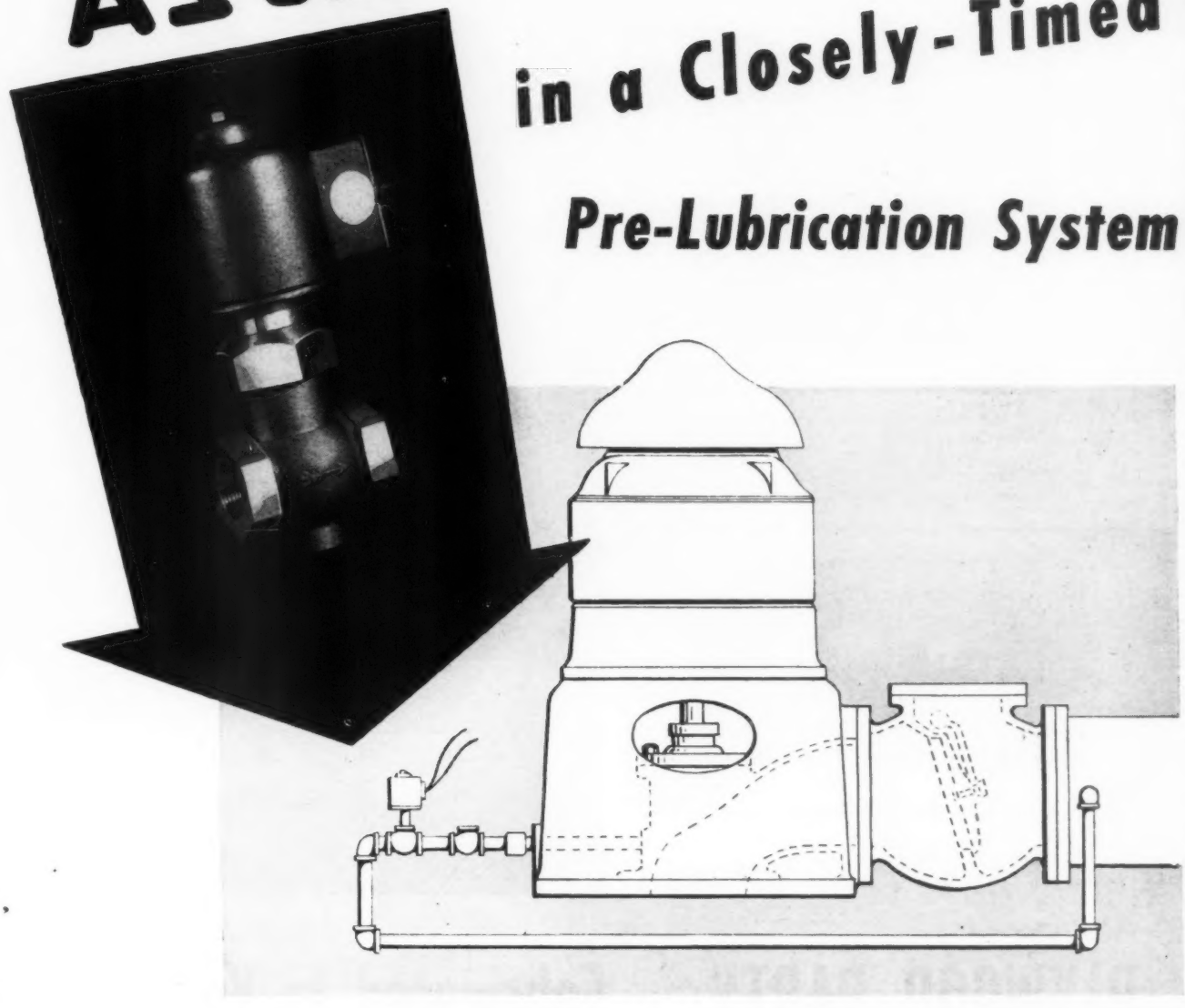


ARMY E NAVY

THE LINDE AIR PRODUCTS COMPANY
Unit of Union Carbide and Carbon Corporation
UCC
30 E. 42nd St., New York 17, N. Y.

BUY UNITED STATES WAR BONDS AND STAMPS

THE ASCO SOLENOID VALVE in a Closely-Timed Pre-Lubrication System



Some close timing is involved in starting this powerful Worthington Turbine Pump . . . and an ASCO Solenoid Valve plays an important part. Through timing relays, the initial closing of the starter switch operates only the valve to flood the rubber column bearings with water. When they are properly lubricated, the relay de-energizes the solenoid valve causing it to close, at the same time closing the Motor Starter Switch.

Note that this ASCO Solenoid Valve is first energized for the purpose of opening it to allow the flow of a liquid. Then it is de-energized, closing it to cut off the flow.

Such an application of the Solenoid Valve has countless uses in industry both in connection with the operation of machines and on process lines carrying liquids or gases.

If you need to automatically and remotely control the flow of liquid or gas in a machine or process line, check up on the usefulness of the solenoid valve. Write us in detail for our recommendations. The ASCO Line of Solenoid Valves is complete. Special types are designed when necessary.

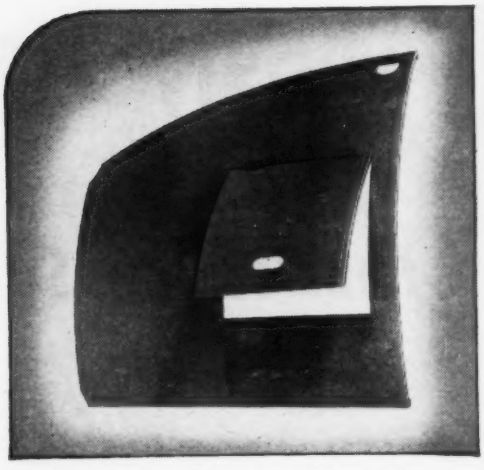
★ ★ ★

We also manufacture a quality line of Automatic Transfer Switches, Remote Control Switches, Contactors and Relays.

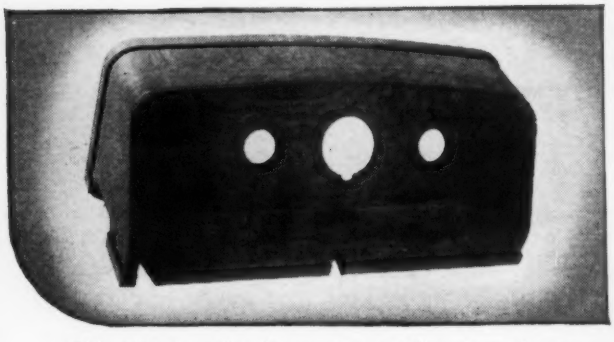
ASCO Solenoid VALVES

Automatic Switch Co.

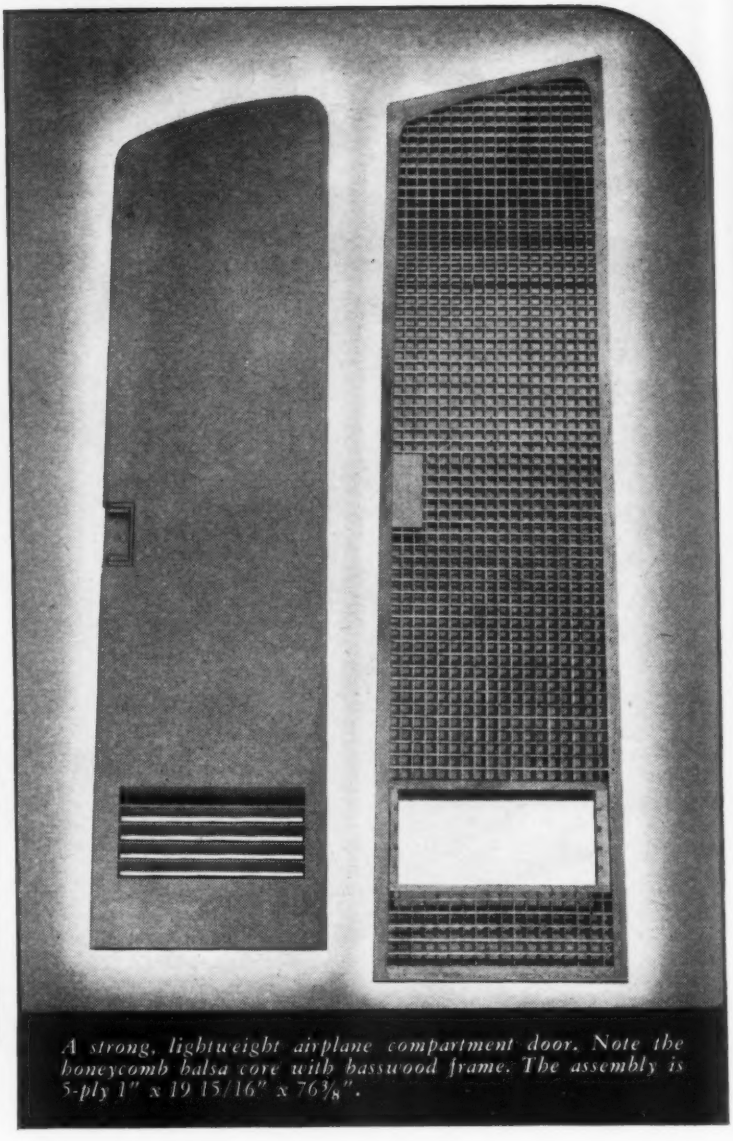
41-M EAST 11th STREET, NEW YORK 3, N. Y.



Wash basin cabinet assembly, used on Douglas Troop Transport Planes. Employing a solid birch frame with laminated spruce stiffeners, it replaced a heavier and more expensive metal assembly.



This Diesel engine instrument cowling is made up of 3/8" Molded Birch Plywood, with birch stiffeners inside. Size — 10" x 11¾" x 28".



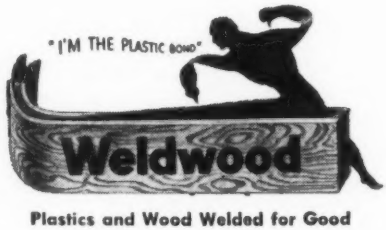
A strong, lightweight airplane compartment door. Note the honeycomb balsa core with basswood frame. The assembly is 5-ply 1" x 19 15/16" x 76⅜".

PLYWOOD PARTS... Fabricated to Your Order

The Fabricated Parts Division of United States Plywood Corporation, located at Plant #2 Algoma, Wisc., offers complete facilities for the production of precision engineered plywood parts.

In addition to the usual equipment required for such production, United States Plywood technicians are frequently called upon to develop special techniques to solve individual problems. Extensive experience plus sound engineering practice have resulted in the economical production of many intricate parts of particular interest to the engineer and designer.

The facilities and experience of the Fabricated Parts Division are at your disposal. Why not use them freely?



Plastics and Wood Welded for Good

WELDWOOD Plywood

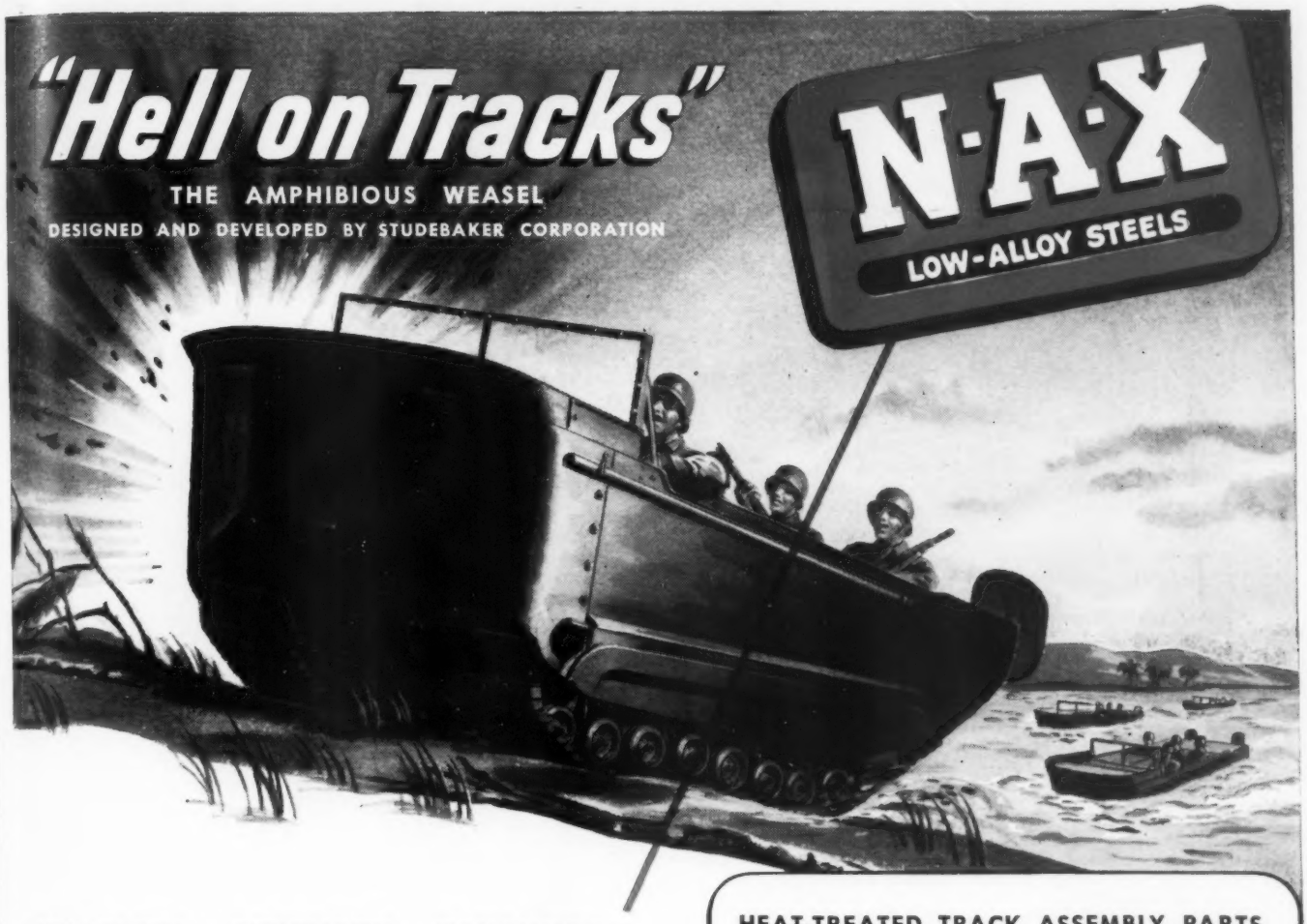
Weldwood Plywood and Plywood Products are manufactured and marketed by

UNITED STATES PLYWOOD CORPORATION

New York, N. Y.

Distributing units in Baltimore, Boston, Brooklyn, Chicago, Cincinnati, Cleveland, Detroit, High Point, Los Angeles, Newark, New York, Oakland, Philadelphia, Pittsburgh, Rochester, San Francisco, Seattle. Also U. S.-Mengel Plywoods, Inc. Distributing units at Atlanta, Jacksonville, Louisville, New Orleans.

Waterproof Weldwood, so marked, is bonded with phenol formaldehyde synthetic resin. Other types of water-resistant Weldwood are manufactured with extended urea resins and other approved bonding agents.



DUCTILITY—STRENGTH—TOUGHNESS PUT N-A-X 9120 ON THE JOB

The track assembly parts of the amphibious Weasel call for something pretty special in *steel* to meet the requirements.

It must have *ductility* to permit cold-forming into difficult stampings. And it must have good *hardenability* and response to heat-treatment to make it strong and tough.

N-A-X 9120 combines these properties in one great steel, and provides in addition excellent weldability for the fabrication of the track shoe. Together, these track parts furnish a good example of the outstanding work being done with versatile N-A-X alloy steels. Consult Great Lakes for assistance in determining the best steel of this series for your particular requirements.

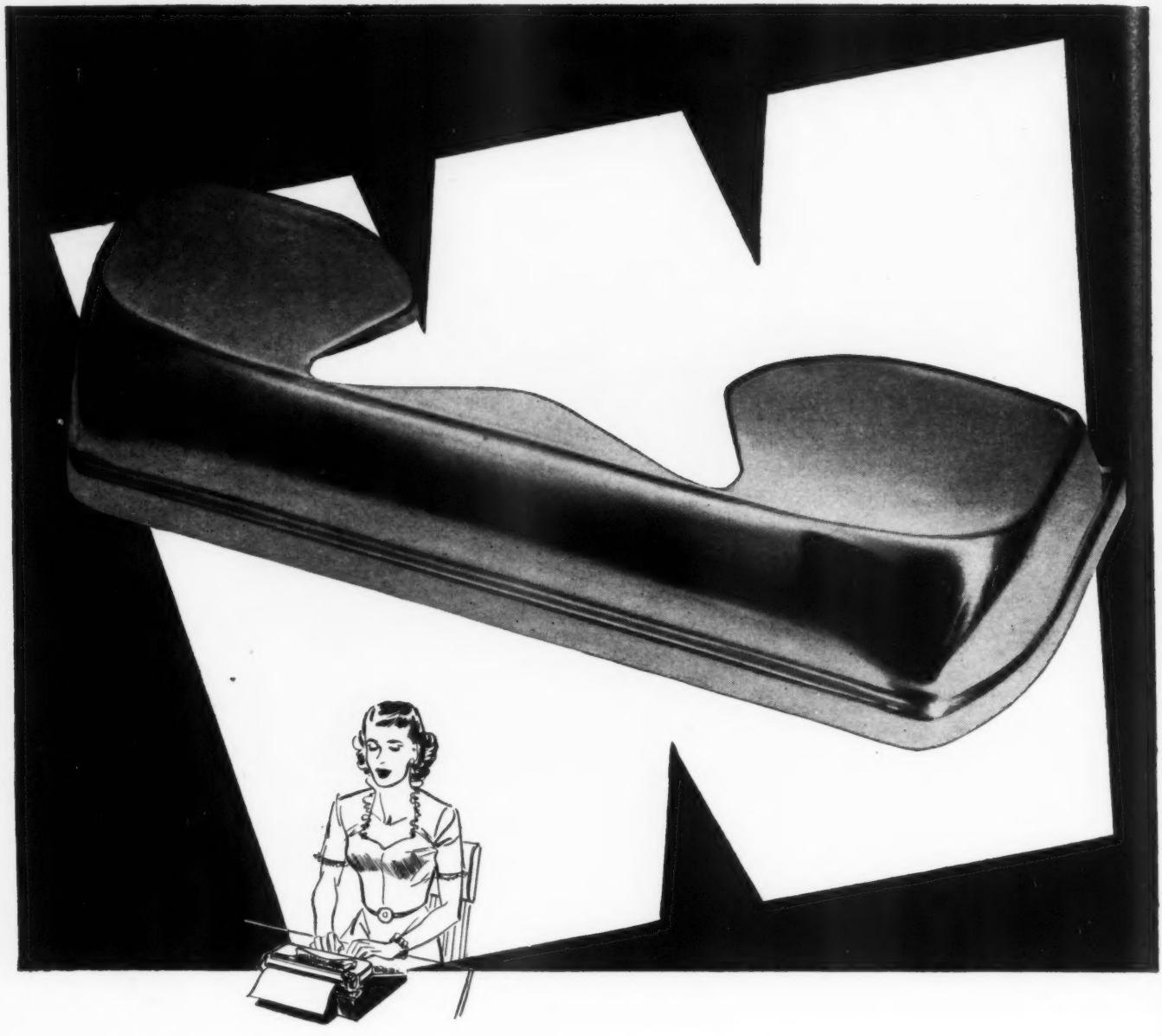
HEAT-TREATED TRACK ASSEMBLY PARTS COLD-FORMED OF N-A-X LOW-ALLOY STEEL

GREAT STEELS FROM GREAT LAKES

GREAT LAKES STEEL *Corporation*

N-A-X ALLOY DIVISION · DETROIT 18, MICHIGAN

UNIT OF NATIONAL STEEL CORPORATION



Presteel Solves a Problem for Typewriter Manufacturer

This manufacturer had always made its own stampings, and had tooled up to produce the steel ribbon cover shown above. Difficulty was experienced in providing enough metal for the rear overhang without wrinkling the top surface. So Presteel was called into the picture, and—as usual—solved the problem.

This manufacturer, incidentally, uses Presteel Cold Rolled Strip Steel for much of its own stamping production.

Few industries have not availed themselves of the services of the Worcester Pressed Steel Company. In all likelihood Presteel has contributed to the development of interchangeable parts for many of the machines in your own offices and shops. Why not investigate the possibilities for lowering costs and improving the quality of your own products by the use of Presteel metal stampings. Mail samples or prints to:

WORCESTER PRESSED STEEL CO.

706 BARBER AVENUE, WORCESTER 6, MASS.

ALLOY STEELS AND OTHER METALS COLD FASHIONED SINCE 1883

for every climatic and atmospheric condition

STEEL AND STEATITE BONDED PERMANENTLY

• Sealex Bushings are designed to operate under all conditions of service, from hot and humid jungle atmospheres to sub-zero low pressure atmospheres encountered by airborne equipment at high altitudes.

The steel and steatite components of these bushings are fused together under high temperature conditions forming a permament hermetic seal impervious to humidity and pressure changes. The unit thus obtained has great mechanical strength. Each design has successfully passed severe temperature, vibration and handling tests to insure against mechanical failure. Each individual bushing is tested in our plant to withstand 50 lbs. p.s.i. air pressure before shipment.

Sealex Bushings are available in single and multiple terminal designs for high and low voltage requirements. Complete specifications and details are available in the Sealex catalogue. Write for your copy today.

ARMY E NAVY

SALES REPRESENTATIVES

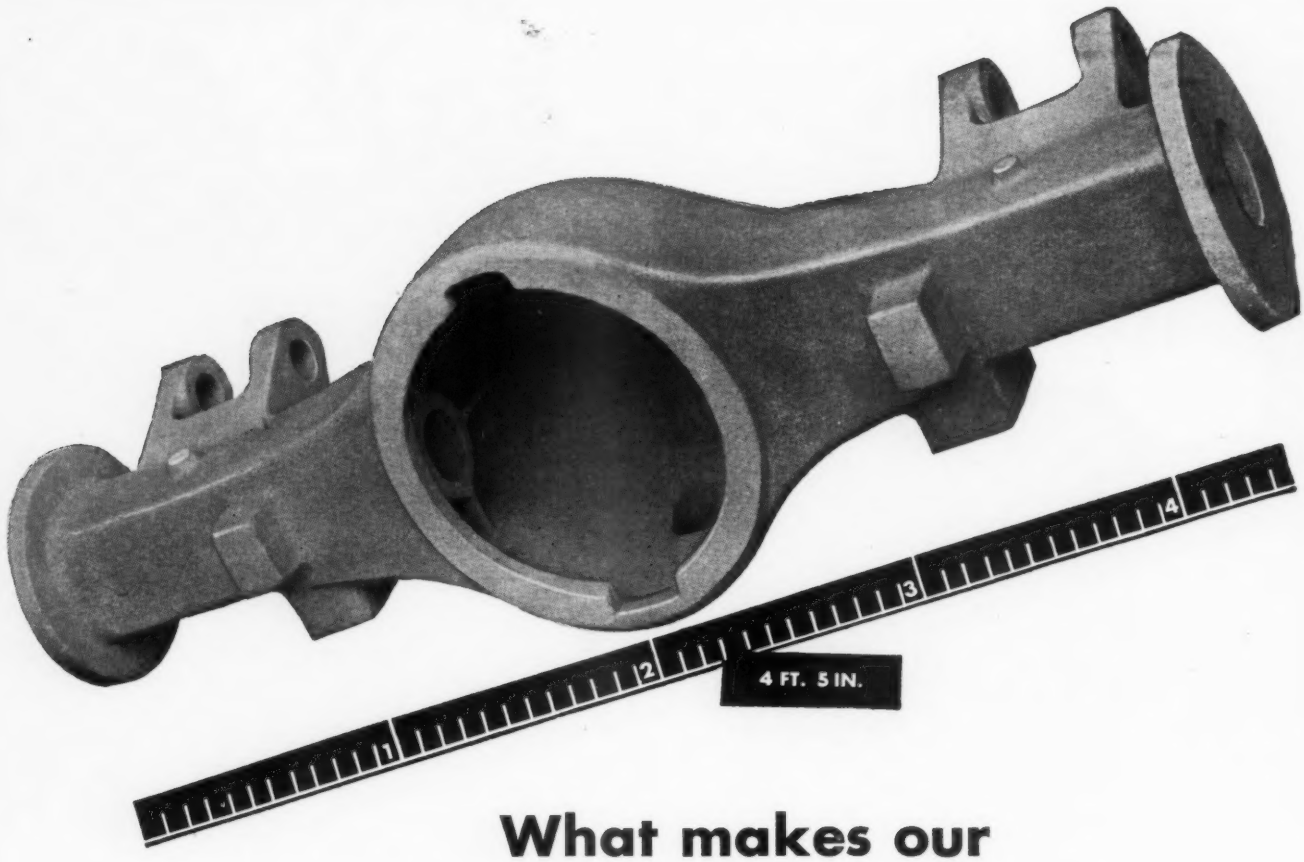
J. J. PERLMUTH & ASSOCIATES
942 Maple Avenue
Los Angeles, Calif.

HARRY W. GEBHARD
737 No. Michigan Avenue
Chicago, Illinois

PAUL R. STURGEON
25 Huntington Avenue
Boston, Mass.

MICA COMPANY OF CANADA LTD.
Hull, Quebec

General Ceramics
AND STEATITE CORP.
GENERAL
KEASBEY
NEW JERSEY



What makes our Motor Vehicles so GOOD?

• The war years have shown how supremely good American motor cars and trucks are.

Millions of the cars running today have stood up, year after year, with a minimum of attention, and almost no replacement parts.

One reason for this record—and an important reason—is that so many crucial automotive parts are steel castings.

These are usually the parts that must take the hard knocks and the grief—parts that are strong, to resist wear and fatigue—parts that have built into them the steel properties that permit them to do their job. A notable example is the truck rear axle housing pictured above.

Here is more proof of the advantages of steel castings—a definite assurance that steel castings can do for your product exactly what they are doing for motor vehicles.

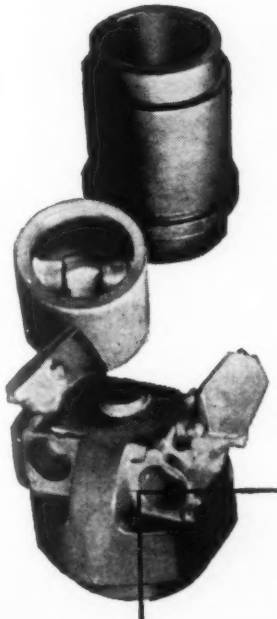
Organized research and broad experience enables the steel founder to deliver to you parts with the properties you need specified in advance.

Steel castings are versatile, dependable, economical. Let your own foundryman tell you more about their possibilities for you. Or write to Steel Founders' Society, 920 Midland Bldg., Cleveland, Ohio.

MODERNIZE AND IMPROVE YOUR PRODUCT WITH

STEEL CASTINGS

Birthplace of many "firsts" in forgings



FORGING efficiency is born when the die for that forging is shaped. This great Tube Turns tool and die shop, largest in the South, has been the "delivery room" for many forgings ideas which have helped speed victory. Out of this shop have come techniques and abilities with steel and light metals, available now to improve industry's peacetime products.

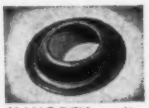
Tube Turns has complete chemical, physical, and electrical laboratory facilities, upset and mechanical press equipment, and modern automatic precision heat treating furnaces . . . all manned by experienced, carefully trained personnel.

Whether your own task of the moment deals with the design of new machines or the improvement of present products, you are invited to submit your problem to Tube Turns. Our engineers will consider your questions promptly, comprehensively, and without obligation. Write to Tube Turns (Inc.), Louisville 1, Kentucky.

TUBE TURNS *Forgings for Industry*

PARTS FABRICATED BY ROGERS

KAYPAR fuel pump protector



KAYGREY radio dust cover

KAYGREY magneto insulator

KAYGREY formed insert

DURO motor slot cell

DUROK capacitor can liner

BAYRU packing list protector

FABRICATED PARTS used to insulate capacitors, loudspeakers, antenna systems and other radio components are now "in work" in Rogers' fabricating division. The radio industry has seen that it can advantageously use Rogers-Bord — and can have Rogers form, draw, punch, bend and shape these tough, high-dielectric materials. Rogers designs and produces the necessary dies in its own tool and die shop. The Rogers "you name it, we'll make it" slogan applies to special fabricating as well as to special fibrous and plastic materials. And it applies *now*.

To learn more, check and mail:

- ☐ Send me the ROGERS EXHIBIT BOX, containing fabricated parts and samples of Rogers-Bord.
- ☐ Have a Rogers representative bring samples and fabricated parts.
- ☐ We are enclosing blueprint for suggestions and quotation.

NAME AND TITLE .....

.....

COMPANY .....

ADDRESS .....

ROGERS CORPORATION
Formerly
The Rogers Paper Manufacturing Co.
113 Mill St., Manchester, Conn.

***DUROK ROGERS-BORD**

Purified, non-cotton, cellulose fibers have now been wet-laminated into a new high-strength, high-dielectric material with the lowest extractibles ever. Data on this electrical insulating surprise are contained in "This Is Durok" Write for it.

CREATORS AND FABRICATORS
ROGERS
FIBROUS AND PLASTIC MATERIALS

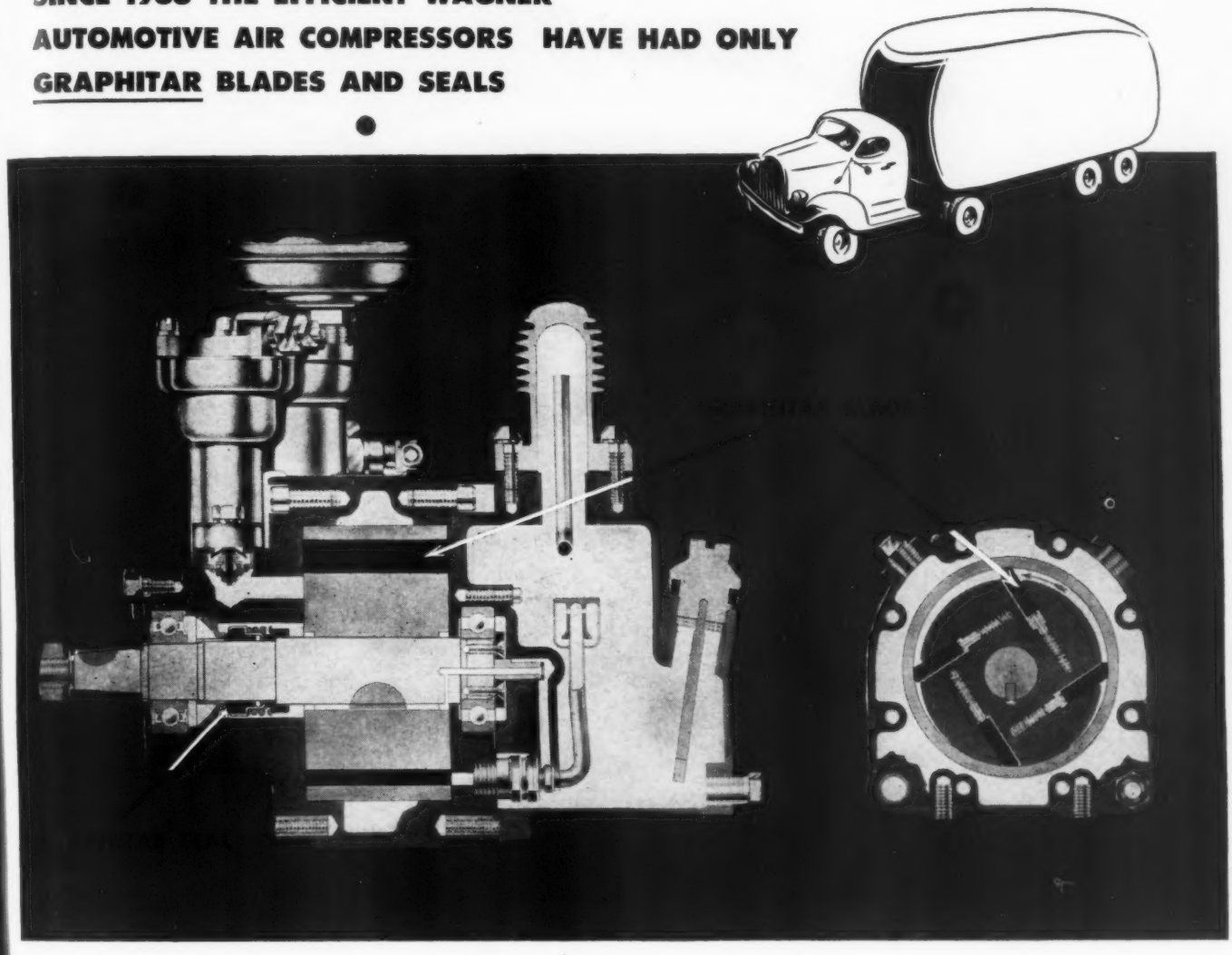
GRAPHITAR PROVES ITS EFFECTIVENESS ON THE JOB

(CARBON-GRAPHITE)

●

SINCE 1938 THE EFFICIENT WAGNER AUTOMOTIVE AIR COMPRESSORS HAVE HAD ONLY GRAPHITAR BLADES AND SEALS

●



One of the most outstanding developments in its field is this rotary compressor which supplies the compressed air for the Wagner automotive air brake systems. In the compressor, air is compressed by blades which must seal very closely, and a positively leak-proof seal must be made where the driving shaft extends from the unit. It is significant that GRAPHITAR has been used for both the blades and the seal for seven years.

Graphitar, which has a chemical analysis of more than 97% all carbon, has proved successful in scores of other industrial applications. Chemically inert, Graphitar is widely used in equipment handling hydrochloric acid, potassium dichromate, sodium hypochlorite, and other corrosive solutions.

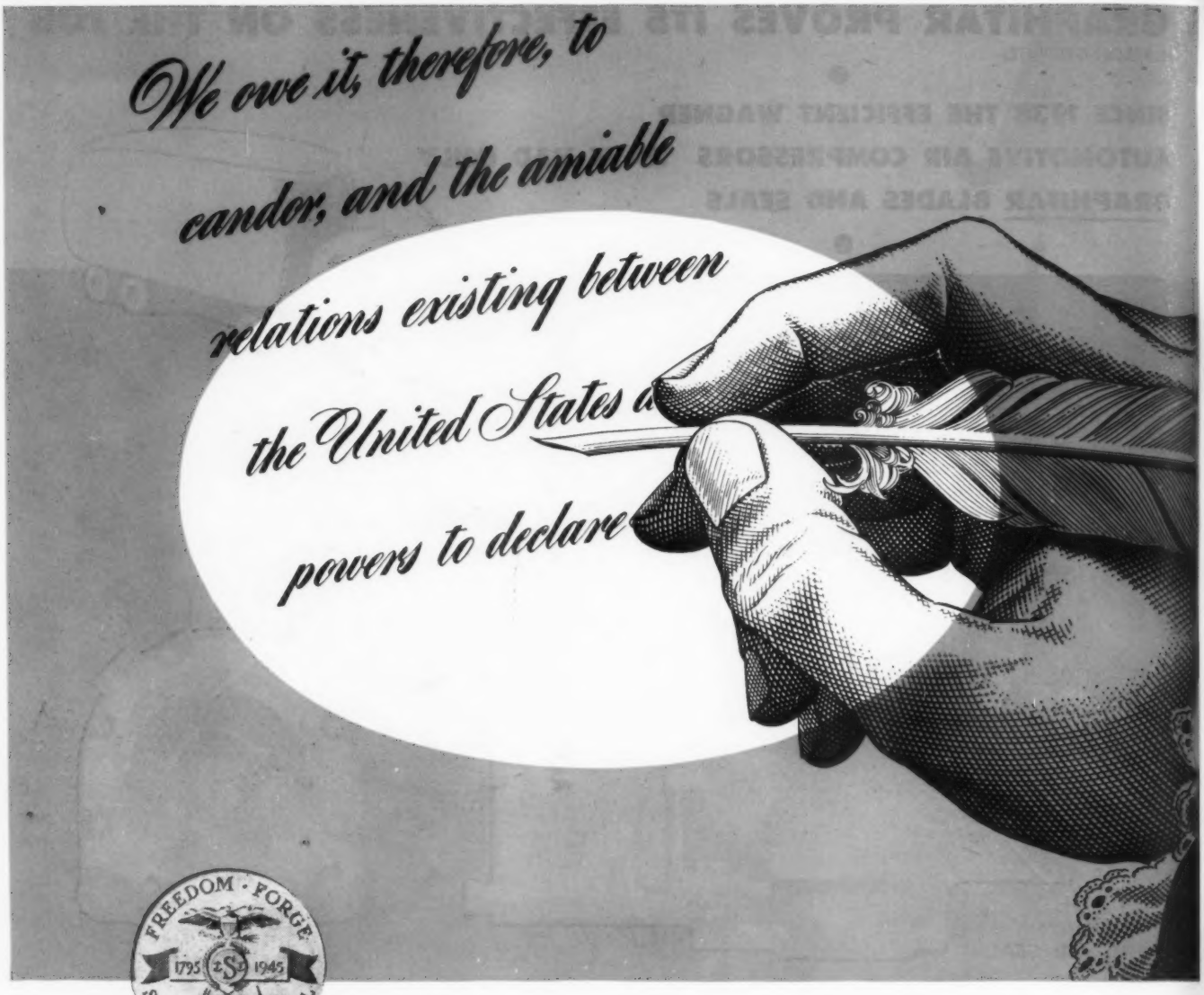
Graphitar has exceptional resistance to wear and frictional heat. Its self-lubricating properties make it especially valuable for inaccessible moving parts. Nonmetallic yet mechanically strong, Graphitar can be machined to almost any shape and to tolerances as close as .0005" on small sizes.

Because it will not melt or fuse at any temperature, it is ideal for use as carrying pads in the glass-making industry, and as bearings and seals in bakery ovens, kiln cars, and steam dryers. It makes serviceable, durable seals and pistons and rings for practically all pump and meter installations. Graphitar may solve a mechanical or engineering problem troubling you. Write for complete particulars.

GRAPHITAR

(CARBON-GRAPHITE)

THE UNITED STATES GRAPHITE COMPANY • SAGINAW, MICHIGAN



In 1823 when the Monroe Doctrine was written

Freedom Forge, then 28 years old, was producing 15 tons of blooms per week

When President Monroe scratched his signature on the doctrine that bears his name, America's industrial age was young. The first American steamboat had crossed the Atlantic only 4 years before; the opening of the Erie Canal was 2 years in the future; the safety lamp, the stethoscope, and the kaleidoscope were recent inventions. Yet Freedom Forge had already served America for almost three decades, and expanded and improved its plant by installing a stack 20-feet high and a bosh 7-feet in diameter. These developments stepped up the output to 12 to 15 tons of blooms and bar iron a week!

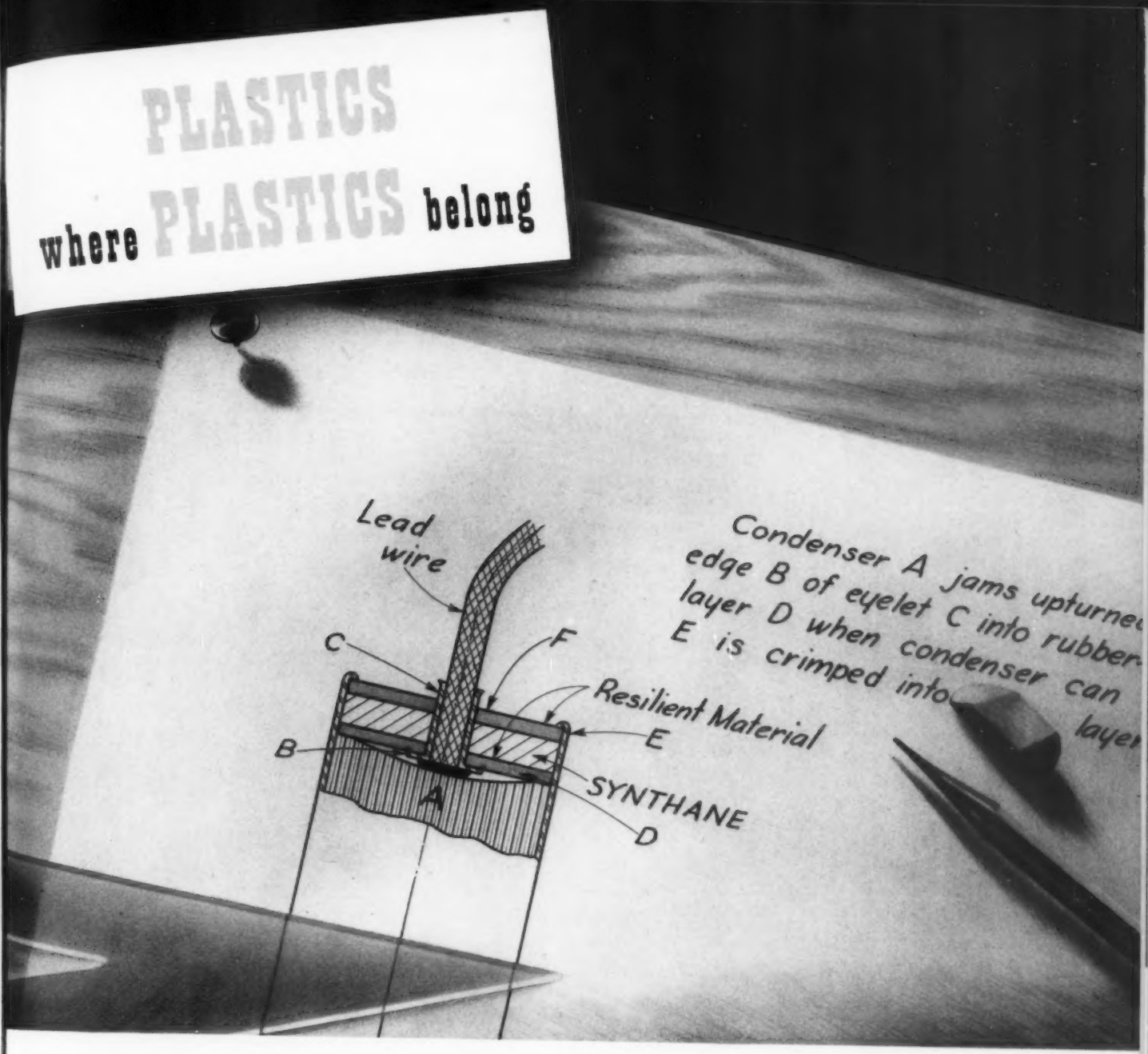
Both the changes and the results seem small in the light of today—but they symbolize a progressive spirit that has continuously ruled the organization. The Standard Steel Works, a direct descendant of Freedom Forge and still doing business at the original location, has pioneered methods and processes that make "Standardize on Standard" a dependable guide to the best in forgings and castings. The Baldwin Locomotive Works, Standard Steel Works Division, Burnham, Pennsylvania, U. S. A. Offices: Philadelphia, New York, Chicago, Washington, Boston, Cleveland, St. Louis, San Francisco, Houston, Pittsburgh, Detroit.

BALDWIN

STEEL FORGINGS & CASTINGS

PLASTICS

where PLASTICS belong



Using Mechanical and Dielectric Strength

SYNTHANE laminated phenolic, sandwiched between and bonded to layers of a resilient material, is the basis of an interesting plastics application.

The assembly—a condenser—depends upon the resilient material for a perfect seal when the edge of the can is crimped. Synthane backs up the resilient material, provides needed strength and rigidity, and is also an excellent electrical insulator, unaffected by condenser oil.

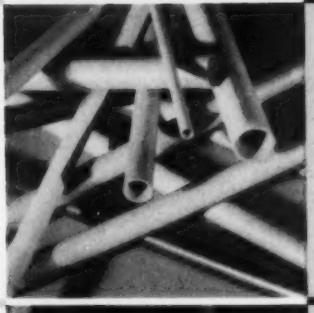
In an application such as this, as in many others, it is desirable to consult our engineers before you design to see if Synthane can be used, and to decide which grade of Synthane will best meet your individual requirements and can be easily and readily produced. In fact, we will work with you from design, through selection of material, down to the delivery of the finished plastics parts, relieving you completely from worry and responsibility. Synthane Fabricated Parts are produced by men who know how to make plastics and how to machine them, using specialized equipment. Synthane Corporation, Oaks, Pennsylvania.

SYNTHANE TECHNICAL PLASTICS DESIGN • MATERIALS • FABRICATION

SYNTHANE

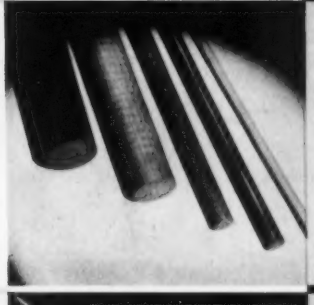
How many of these forms of Synthane do you recognize . . . and use?

1 SYNTHANE SHEETS
Made by curing layers or laminations of impregnated paper or fabric with heat and high pressure.

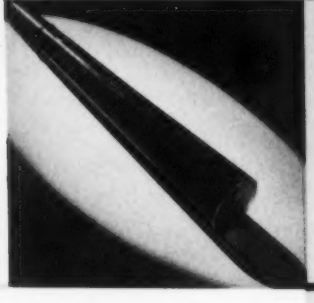


2 SYNTHANE WRAPPED TUBES
Made by curing impregnated paper or fabric, wound about a mandrel, with heat.

3 SYNTHANE MOLDED TUBES
Same as wrapped tubes except tubes are cured under heat *and* pressure in molds.



4 SYNTHANE RODS
Produced by a method similar to that used in processing molded tubes.



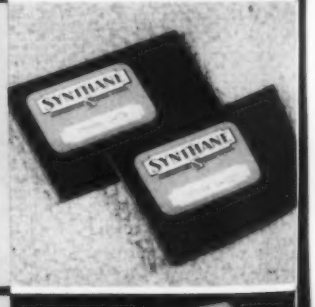
5 SYNTHANE MOLDED-LAMINATED
A means of producing parts in a finished or nearly finished form by curing layers of sheets under heat and pressure in molds. An economical way of making parts in quantity, retaining the desirable strength characteristics of Synthane sheet material.

6 SYNTHANE MOLDED-MACERATED
Flakes of impregnated fabric are cured under heat and pressure in molds. More intricate parts can be formed than are possible by molded-laminated. Strength surpasses ordinary powder molding, does not equal molded-laminated.

7 COMBINATION MOLDED-LAMINATED, MOLDED-MACERATED Some parts requiring strength in certain sections but intricacy in others may be made by a combination of the molded-laminated, molded-macerated methods.

8 COMBINATION MATERIALS
Synthane is sometimes bonded under pressure to other materials to achieve a combination of properties not obtainable any other way. The resiliency of rubber or Neoprene is often teamed with the strength and insulating characteristics of Synthane.

9 SPECIAL MATERIALS
Synthane is available in special forms such as this graphited anti-friction Synthane. The inclusion of graphite is desirable on some applications.



10 FABRICATED PARTS
Synthane produces finished parts by machining sheets, rods, tubes or by molded-laminated or molded-macerated processes or by combining machining and molding operations.

SYNTHANE CORPORATION, OAKS, PENNA.

SYNTHANE

Representatives in All Principal Cities

PLAN YOUR PRESENT AND FUTURE PRODUCTS WITH SYNTHANE TECHNICAL PLASTICS · SHEETS · RODS · TUBES · FABRICATED PARTS · MOLDED-LAMINATED · MOLDED-MACERATED

A New Service!

Engineering IN FABRICS...

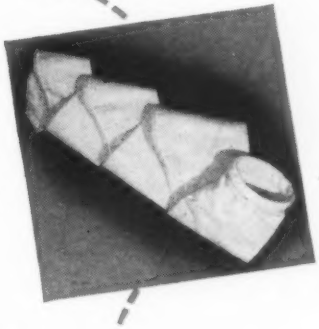
How You Benefit!

"Engineering" when applied to the industrial use of fabrics brings you the same advantage it does when metal, plastic or wood are the materials used.

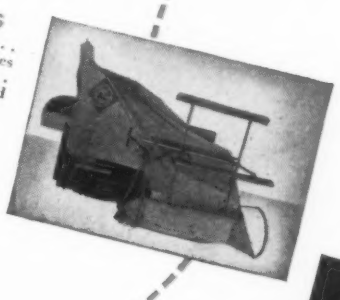
Brings you Better Parts... Accessories ... and Products!

- FABRIC PARTS in hundreds of ways are achieving increased performance, longer life and lower costs.
- FABRIC ACCESSORIES fulfill a need of the user and offer the manufacturer an additional item for profit.
- FABRIC PRODUCTS, through "Engineering in Fabrics", are fully utilizing the improved methods of treating and coating standard fabrics and gaining the advantages of the many new war-developed synthetic fibers.

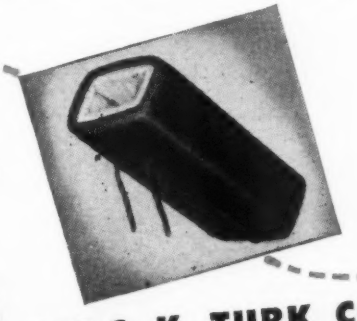
FABRIC PARTS
Dust Arrestors . . . Conveyors . . . Boots Ducts . . . Bellows . . . Diaphragms . . . etc.



FABRIC ACCESSORIES
Fitted Covers . . . Curtains . . . Cases . . . Containers . . . Tool Rolls . . . and other items.



FABRIC PRODUCTS
Insulated Cases . . . Baskets . . . Tanks . . . Umbrellas . . . Buffing Tents . . . Tarpaulins . . . etc.



What We Can Do!

THE C. K. TURK CORPORATION
Product Development Division
333 North Michigan Avenue • Chicago 1, Illinois
Factory and Home Office: South Bend, Indiana

Turk's "Packaged" Engineering Plan Offers You These Services!

DESIGN . . . the first step toward building functional advantages and economies into your industrial fabric parts or products is to call in a Turk Engineer for competent design counsel.

FABRIC . . . Turk's broad knowledge and daily contacts in the field of fabrics will prove invaluable in selecting just the right fabric for your product.

PRODUCTION . . . modern methods and machines combine with the skill of experienced workers to make the fabric products produced by Turk the very highest in quality and satisfaction.

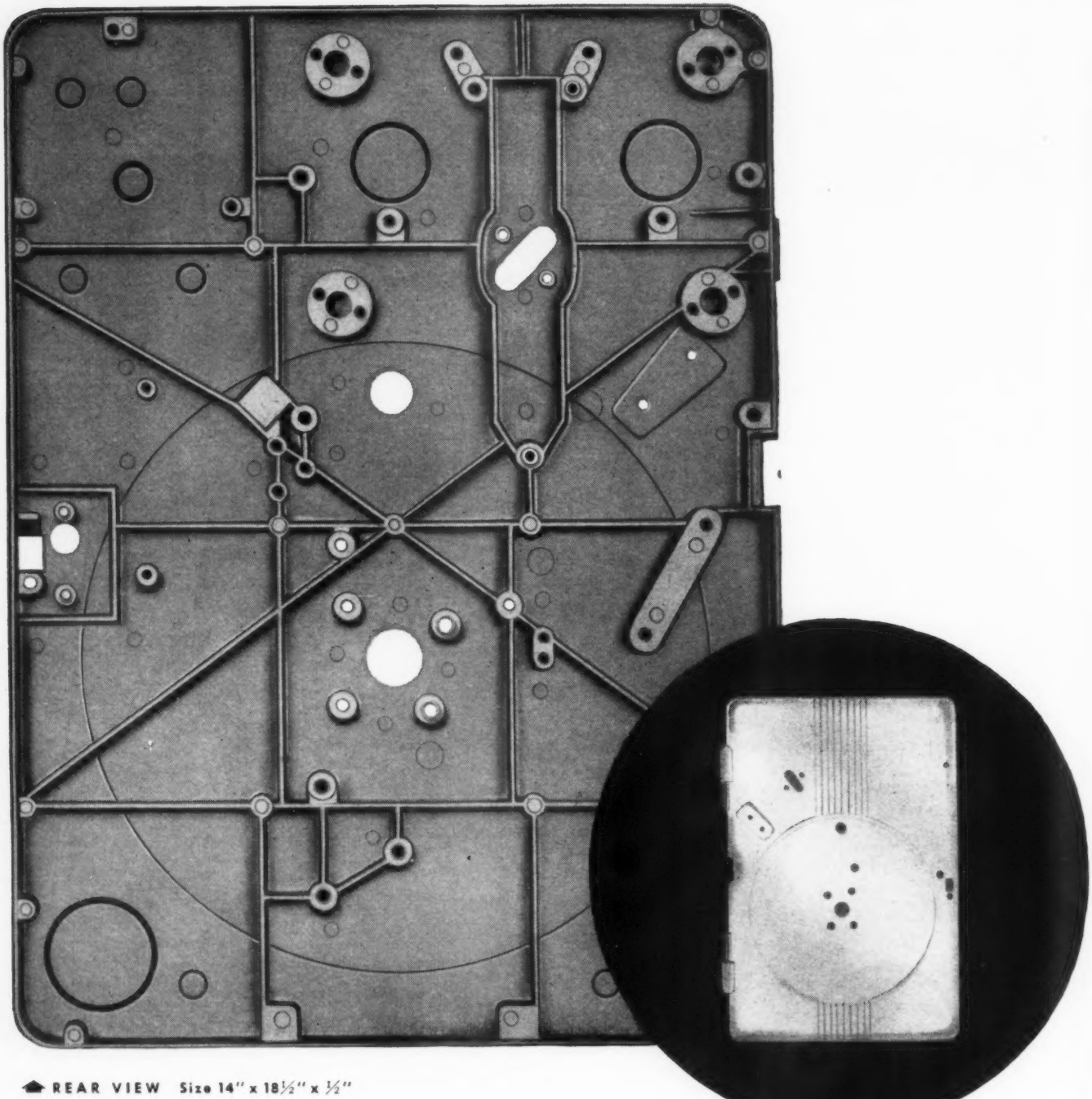
FABRICator TO INDUSTRY

Fill-in and mail today . . . and we'll go to work for you tomorrow!

C. K. TURK CORPORATION, 333 North Michigan Avenue, Chicago 1, Illinois
We want information regarding your "Engineering in Fabrics" service as applied to the specific items checked and described below.

☐ Fabric Parts
☐ Fabric Accessories
☐ Fabric Products

Name _____ *Company* _____
Address _____ *City* _____ *State* _____



REAR VIEW Size 14" x 18½" x ½"

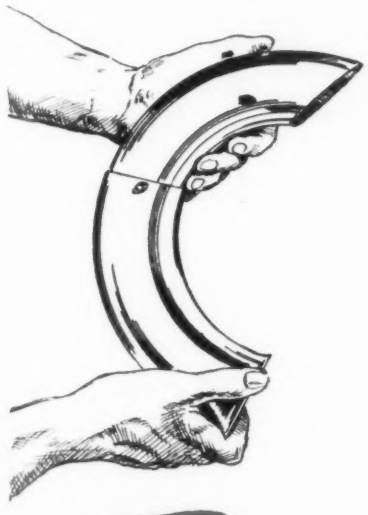
FRONT VIEW

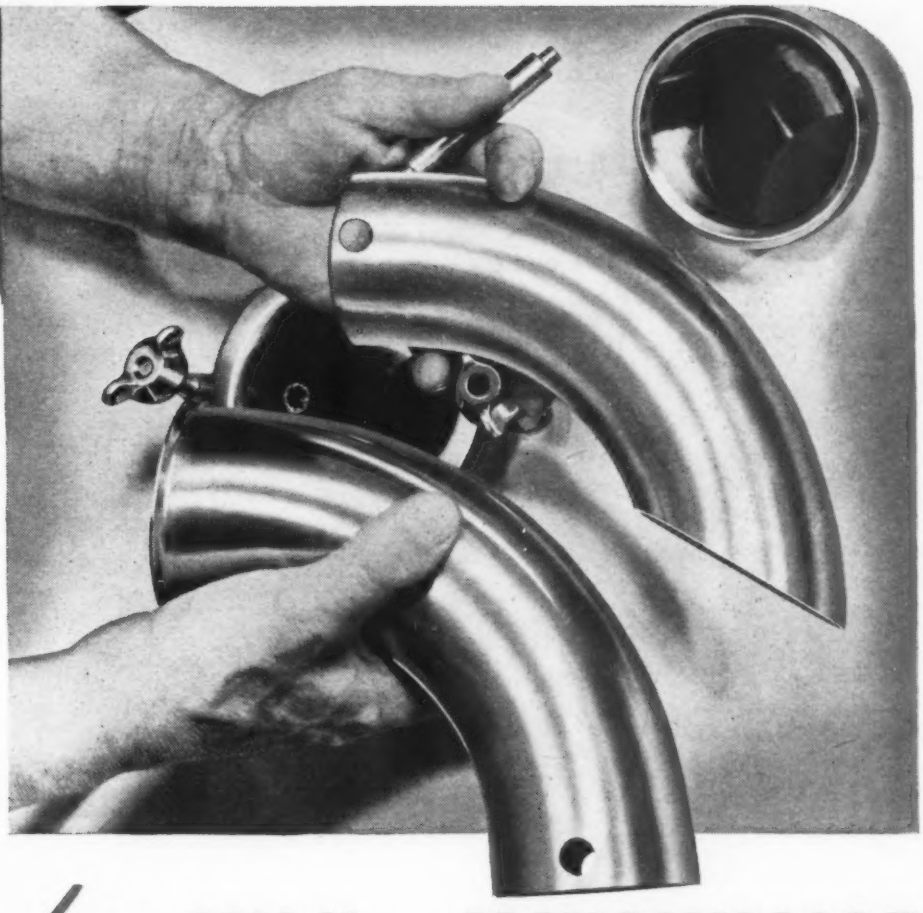
This Very Difficult Die Casting *is saving man hours, machining time and weight in its application to equipment used by the armed forces . . . a typical Parker job made possible by Parker's more than 38 years of "know how" in die-casting.*

PARKER WHITE METAL AND MACHINE CO • 2144 McKINLEY AVENUE, ERIE, PA.

PARKER ALUMINUM *and* ZINC *Die Castings*

This stainless steel inlet for a milk storage tank is made in two pieces so that, when disassembled for washing, the entire surface is open to visual inspection.





Safe for MILK or MAYONNAISE

..strong..tough..resistant to wear

• Wherever tubing comes in contact with "delicate" products—even easily contaminated foods such as milk or mayonnaise — Republic ELECTRUNITE Stainless Steel Tubing is more than *SAFE* to use.

It's safe — because it is clean, sanitary, and easy to keep clean. It resists corrosion. It does not contaminate metallically. These statements have been proved by a 25-year record established by ENDURO—the metal from which this tubing is made.

And it's strong, tough, resistant to wear. There's no danger of breakage—no wearing through of the surface—because it's solid stainless steel throughout.

But there's even more to the story when you use tubing made by the ELECTRUNITE Process. There's a consistent uniformity of wall thickness, diameter, roundness and workability.

ELECTRUNITE Stainless Steel Tubing is made in a wide range of sizes, gauges, finishes and analyses. For further information, write to:

REPUBLIC STEEL CORPORATION
STEEL AND TUBES DIVISION • CLEVELAND 8, OHIO
Export Department: Chrysler Bldg., New York 17, N. Y.

Republic
ELECTRUNITE
Reg. U. S. Pat. Off.
STAINLESS STEEL TUBING

Also Carbon Steel Mechanical Tubing—Aircraft Tubing—Boiler, Condenser and Heat Exchanger Tubes

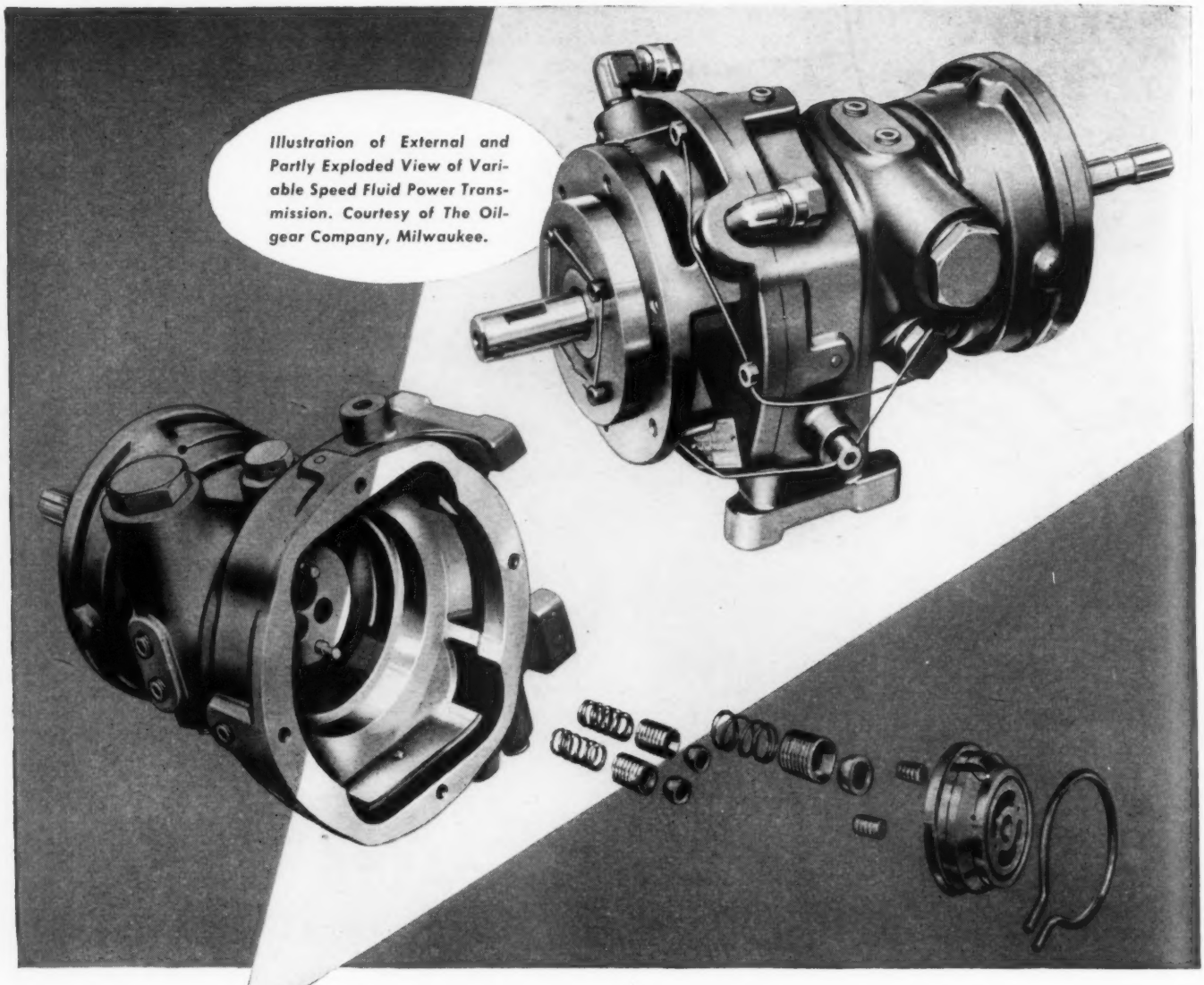


Illustration of External and Partly Exploded View of Variable Speed Fluid Power Transmission. Courtesy of The Oilgear Company, Milwaukee.

Special Lowe Brothers Finish Protects Hydraulic Fluid Power Units

Corrosion, core sand and foreign elements are enemies of hydraulic units, transmissions and gear housings, which use oil to transmit power in many types of precision mechanisms. Ingenious design and accurate workmanship are virtually useless unless the interior of cast housings is adequately finished to eliminate these problems.

A special paint coating, developed several years ago by Lowe Brothers, has proved the answer to these problems. It is a sealer which may be either brushed or sprayed with consistently satisfactory results.

The application of this sealer to the interior of cast housings seals in any core sand and foreign elements not removed in casting preparation.

It will not chip off nor permit corrosion to gum the oil.

It stands up perfectly under constantly circulating hot oil.

The sealing and protecting qualities of this Lowe Brothers finish thus safeguards the entire unit against disastrous effect of foreign matter detrimental to working parts.

Whatever your finish problem, Lowe Brothers experience in serving designers and makers of machines and precision equipment, is at your disposal. Your request for advice involves no obligation.

INDUSTRIAL SALES
THE LOWE BROTHERS COMPANY
DAYTON, OHIO

Lowe Brothers
FINISHES for Industry

TO DESIGNERS AND ENGINEERS:

An Interesting Proposition

UNUSUAL DESIGN IN STEEL = *The USUAL THING at SPUN STEEL*

SPUN STEEL engineers make their primary work the development of drive and driven pulleys for special applications. Spun Steel production centers around the exclusive automatic roller-forming process which insures balance, concentricity, and smooth effective belt surfaces on all SPUNSTEEL single and multiple V-groove pulleys. Precision tolerances are maintained.

Equipment and minds at SPUN STEEL are flexible. Here war production is speeded by unusual application of stamping, brazing, welding, and roller-forming techniques. Your problems can be met with our continuing ready interest and increased knowledge. Write, outlining your needs, enclosing blueprints if you have them, desk-pad doodles if you don't!

METAL ENGINEERING WORKS WONDERS IN STEEL

Heavy, costly, machined parts using bar stock or forgings have been — and can be—replaced by Spun Steel designs for assemblies of stampings. Colorful 6 page brochure tells in text and pictures how you can reduce your costs, speed production with "Metal Engineering." Write today!

THE Spun Steel CORPORATION

ARMY E NAVY

SPUNSTEEL

2041 DUEBER AVENUE, S. W., CANTON 6, OHIO

BET YOU NEVER HEARD THIS ONE!

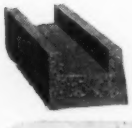
This is a story of noise abatement. It's about a manufacturer who discovered an easy, inexpensive way to banish the clang and rumble from domestic stokers – and thereby give them "buy-appeal" they never had before.

The trick was turned simply by applying Spongex* Molded Cord to parts where metal met metal. By cleverly gasketing with this soft, lively material, sound was hushed to a whisper – vibration reduced to the vanishing point. And the cost per unit for Spongex Cord was little more than you'd gladly pay for a package of your favorite cigarettes (if you could buy 'em!).

The point of this stoker story is obvious: You may have a similar problem in your own product. If it isn't noise or vibration, it may be sealing, insulating, or cushioning. You'll find Spongex Cord ideal for all these purposes. This versatile material has more "angles" than a Norden bombsight! It can be compounded to resist gasoline, oil and corrosive chemicals. Under repeated or prolonged compression, it springs back to its original shape.

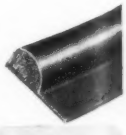
Spongex Molded Cord is only one of a legion of products representing more than two decades of development in cellular rubber. You can use cellular rubber to advantage – and profit! Just give us a description or sketch of your problem. Sponge Rubber Products Co., 123 Derby Place, Shelton, Conn. Plants in Derby and Shelton, Conn. Sales Offices: New York, Chicago, Washington, Detroit.

*Trade Mark Reg. U. S. Pat. Off.



Full and half-round cord or tubing and molded strips in various shapes for any sealing or gasketing job.

Spongex is a resilient, flexible blown form of rubber available in soft, medium and firm densities.



SPONGE RUBBER PRODUCTS CO.

WORLD'S LARGEST MANUFACTURER OF CELLULAR RUBBER AND BONDED FIBRE PRODUCTS

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Few manufacturers possess the versatile production facilities of The Standard Products Company.

Standard is prepared to develop and plan for industry, parts of molded rubber, steel stampings, plastics, in almost any shape or form.

The services of The Standard Products Company Research Laboratory and Engineering Departments are at your disposal. Let us have the necessary data and our engineers will submit designs and proposal.

The Standard Products Company is the world's largest manufacturer of glass run window channel and contour weather strip. Production and replacement channel for passenger cars, truck cabs, busses, motor boats, airplane cabins and streamlined trains is now available for delivery.

Your inquiries are solicited.

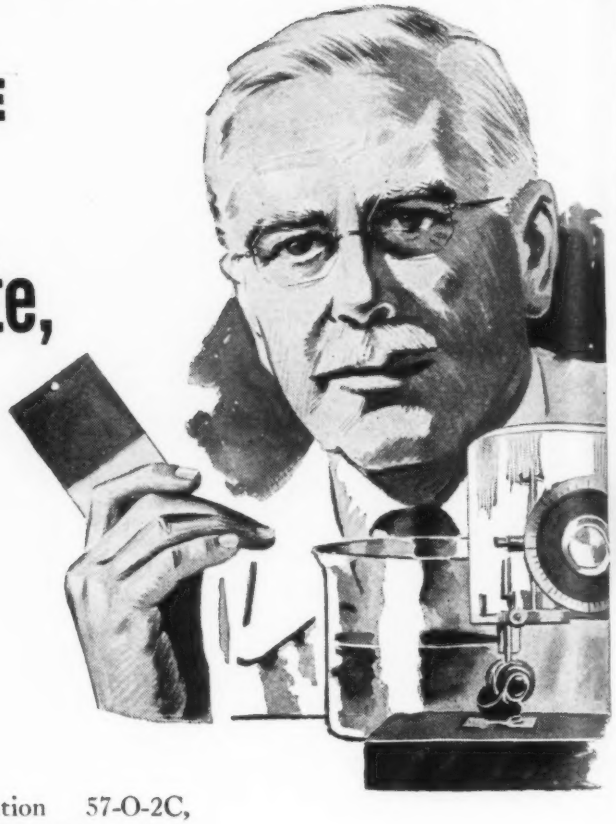
THE STANDARD PRODUCTS COMPANY

Administrative and Sales Offices

505 Boulevard Bldg. • Woodward Ave. at E. Grand Blvd. • Detroit 2, Michigan

"Find out how IRIDITE Balks Corrosion of

✓ Zinc or Cadmium Plate,
✓ Zinc Die-Castings,
✓ and Galvanized!"



DON'T take our word for it! Mail the coupon below for free test panel and see for yourself how Iridite heads off corrosion on zinc die-cast, zinc or cadmium plated or galvanized surfaces . . . why Iridite is so widely used as a final finish or paint base.

Easy, Quick-Dip Process

Iridite goes on with a quick dip of 15 to 60 seconds, is easily dried, is dried even faster with a hot water rinse, permits immediate handling or shipping. What's more, Iridite keeps production moving, maintains automatic machine cycles, needs no special personnel or equipment.

Used by Leading Companies

Used throughout industry, the Iridite process meets Army-Navy Aeronautical Specification AN-P-32A, Army Ordnance Specification 57-O-2C, Navy Specification OS-1374, and is used by such leading manufacturers as Bulova, Pyrene, Sparton, York, Anaconda and many others.

Test Iridite Yourself

Send for free test panel, half of it protected by Iridite, and prove for yourself how Iridite balks corrosion . . . how the Iridite treatment does not alter dimensions of finely machined parts . . . how Iridited parts may be twisted or bent without flaking, chipping or peeling. Find out whether or not Iridite is the ideal "finishing touch" for your present or postwar product. Write today for your test panel. Address: Rheem Research Products, Inc., 14307 Standard Oil Bldg., St. Paul and Franklin Streets, Baltimore 2, Maryland.

3 WAYS TO BUILD PROFITS WITH IRIDITE

1 ***As a final finish,*** Iridite is available in a variety of attractive colors.

2 ***As a paint base,*** Iridite holds paint firmly, even on newly galvanized surfaces.

3 ***To reduce costs,*** consider using galvanized, plus Iridite, in place of more expensive metals.

Mail Coupon for FREE Test Panel!

RHEEM RESEARCH PRODUCTS, INC.

IRIDITE*

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Branches—570 Lexington Ave., New York 22; 20 E. Jackson Blvd. Chicago 4; 2411 Sichel St., Los Angeles 31. Distributors in: Waterbury; Grand Rapids; Detroit; Cleveland; Los Angeles; Long Island City; St. Louis.

* Patent applied for

RHEEM RESEARCH PRODUCTS, INC.,
14307 Standard Oil Building
Baltimore 2, Maryland

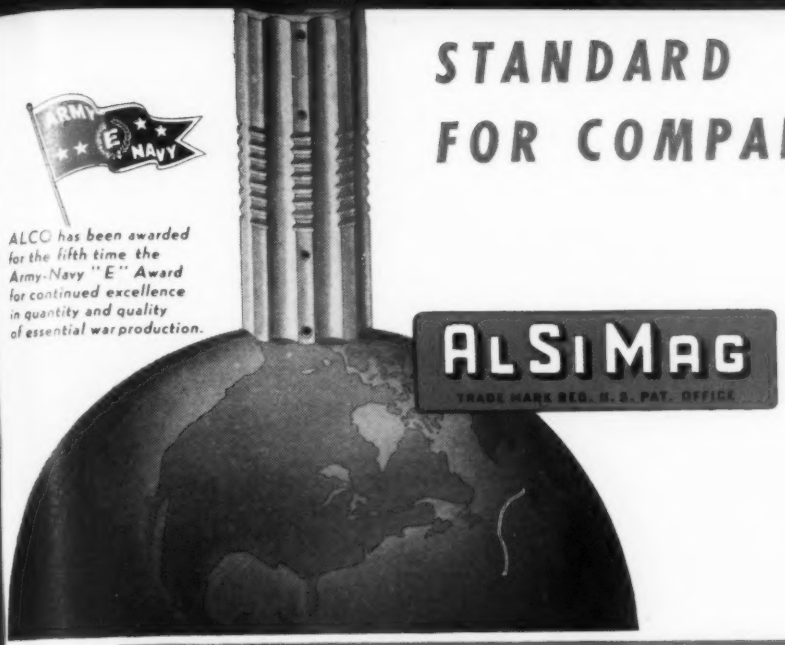
GENTLEMEN: Please send me a free panel of Iridite-treated zinc plate for laboratory testing and full information and operating details.

Name.....

Company.....

Address.....

Keep faith with your fighters and yourself—Buy War Bonds for Keeps



ALCO has been awarded for the fifth time the Army-Navy "E" Award for continued excellence in quantity and quality of essential war production.

STANDARD FOR COMPARISON

IT is a fact that other materials offered as insulators for electronic and electrical use *may be judged by the degree to which they approach the combined properties of* ALSIMAG *Steatites.* Study the Property Chart shown below. Whatever you are planning in the electronic or electrical field, the chances are ALSIMAG will do it better. Our specialized knowledge, and our engineering and research facilities are at your service. Let's work together.

AMERICAN LAVA CORPORATION

Chattanooga 5, Tennessee

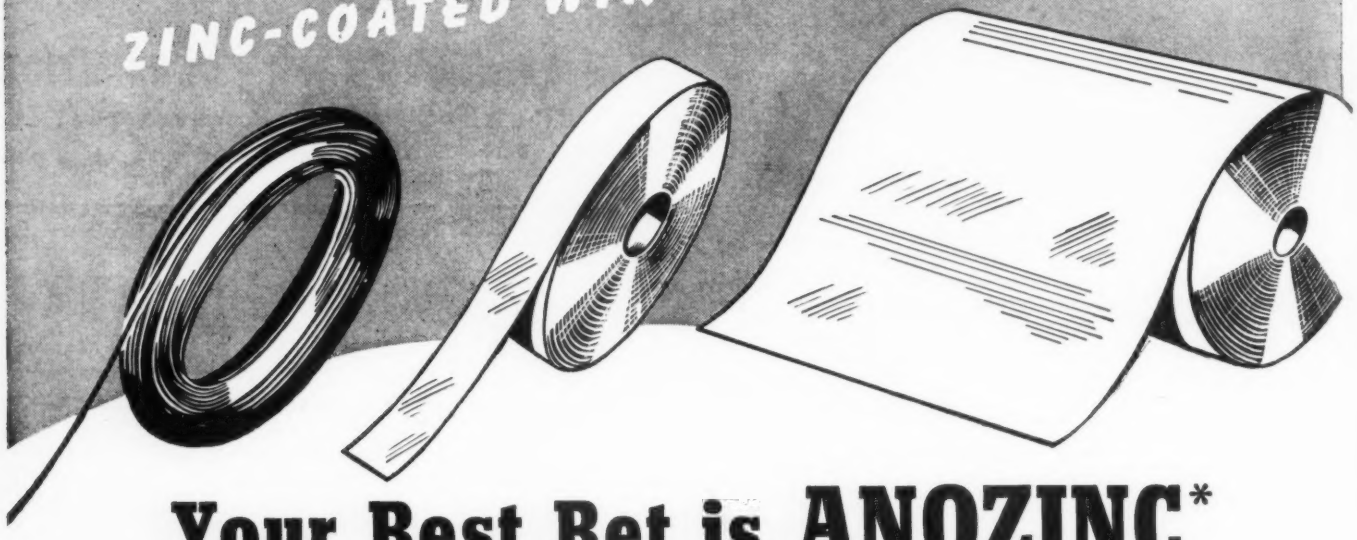
43RD YEAR OF CERAMIC LEADERSHIP

MECHANICAL AND ELECTRICAL PROPERTIES OF ALSIMAG CERAMICS

ITEM	A.S.T.M. TEST NUMBER	UNIT	STEATITE				
			ALSIMAG A-35	ALSIMAG A-196	ALSIMAG 197	ALSIMAG 211	ALSIMAG 243
Specific Gravity	——	——	2.5	2.6	2.6	2.7	2.8
Density	——	lbs. per cu. in.	.090	.094	.094	.098	.101
Volume	——	cu. in. per lb.	11.11	10.64	10.65	10.26	9.91
Water Absorption	D116-42(A)	%	0—.05	0—.05	0—1	.08	0—.05
Color	——	——	White	White	White	White	Buff
Softening Temperature	C24-35	°C. °F.	1 450 2 642	1 440 2 624	1 445 2 633	1 400 2 552	1 440 2 624
Resistance to Heat (Safe Limit for Constant Temperature)	——	°C. °F.	1 000 1 832	1 000 1 832	1 000 1 832	1 000 1 832	1 000 1 832
Hardness	——	Mohs' Scale	7.5	7.5	7.5	7.5	7.5
Linear Coefficient of Thermal Expansion 25-100°C. 25-600°C.	—— ——	Per °C.	6.9×10^{-6} 8.7×10^{-6}	7.3×10^{-6} 8.9×10^{-6}	7.7×10^{-6} 10.4×10^{-6}	7.3×10^{-6} 9.2×10^{-6}	9.1×10^{-6} 10.4×10^{-6}
Tensile Strength	D116-42	lbs. per sq. in.	8 500	10 000	8 500	7 500	——
Compressive Strength	D667-42T	lbs. per sq. in.	75 000	85 000	75 000	65 000	85 000
Flexural Strength	D667-42T	lbs. per sq. in.	18 000	20 000	20 000	18 000	20 000
Resistance to Impact (½" rod)	Charpy D667-42T	inch-lbs.	4.5	5	1.8	2.0	——
Thermal Conductivity (Approximate Values)	——	cal./sec./cm. per °C.	.006	.006	.006	.006	.008
Dielectric Strength (step 60 cycles) Test discs ¼" thick	D667-42T	volts per mil	225	240	210	240	240
Volume Resistivity at Various Temperatures 25°C. 77°F.	——	Ohms per Centimeter Cube	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$
100°C. 212°F.			2.1×10^{12}	1×10^{13}	8.1×10^{13}	$>10^{14}$	5.0×10^{13}
300°C. 572°F.			6.0×10^{7}	1.8×10^{9}	2.5×10^{10}	9.0×10^{12}	7.0×10^{11}
500°C. 932°F.			3.2×10^{5}	9.0×10^{6}	8.8×10^{7}	3.5×10^{10}	1.2×10^{10}
700°C. 1 292°F.			2.3×10^{4}	5.0×10^{5}	4.2×10^{6}	4.8×10^{8}	1.0×10^{8}
900°C. 1 652°F.			7.0×10^{3}	7.0×10^{4}	6.8×10^{5}	2.5×10^{7}	3.0×10^{6}
Te Value	——	°C. °F.	440 824	640 1 184	840 1 544	> 1 000 > 1 832	> 1 000 > 1 832
Dielectric Constant 60 Cycles	D667-42T	——	6.1	5.9	6.3	——	6.3
1 000 K. C.			5.9	5.8	6.0	5.8	6.2
10 M. C.			5.8	5.7	5.8	5.7	6.2
Power Factor 60 Cycles	D667-42T	——	.015	.0022	.0020	——	.0014
1 000 K. C.			.0035	.0021	.0012	.0004	.0004
10 M. C.			.0030	.0015	.0010	.0003	.00035
Loss Factor 60 Cycles	D667-42T	——	.09	.013	.0126	——	.0088
1 000 K. C.			.021	.012	.0072	.0023	.0025
10 M. C.			.017	.008	.0058	.0017	.0022
Capacity Change Per °C.	——	parts per million	+160	+160	+160	+120	+130

EXTRA CORROSION RESISTANCE

Applied Continuously to ZINC-COATED WIRE—STRIP—SHEETS



Your Best Bet is ANOZINC*

Add another important plus to the big features of the ANOZINC process! You can increase corrosion resistance of zinc-coated sheets, strip or wire *in a continuous operation* by finishing them in an ANOZINC bath.

It's an inexpensive anodic treatment that greatly extends the resistance of zinc coatings to outdoor exposure, aging and corrosion. Over 200 hours under A-N salt-spray tests prove that fact.

Here are other important advantages:

LOW COST because Anozinc salts are moderately priced; the operating cycle is short and standard drying procedures are used.

EASY TO HANDLE because the bath operates at room temperature; uses ordinary plating facilities; is readily maintained without frequent additions.

3 ATTRACTIVE COLORS to choose from:—Clear Anozinc retains the lustre and appearance of new zinc; Yellow Anozinc gives a brassy, slightly iridescent finish; Black Anozinc for a deep, rich black.

Wherever you want better appearance on zinc surfaces — or a better paint base — your best answer is ANOZINC. Write for further information, giving a brief outline of your application.

OTHER U.C. PRODUCTS AND PROCESSES TO SERVE YOU

CHROMIUM PLATING for wear-resisting, oil-retaining and other types of finishes.

☆**UNICHROME ALKALINE COPPER** for smooth lustrous copper plating in a non-cyanide bath.

☆**UNICHROME DIP** for increased corrosion resistance of zinc and cadmium—without electric current.

☆ Trade Mark U.S. Pat. Off.

☆**UNICHROME STRIP** for speedy removal of copper, chromium, zinc, etc.

☆**UNICHROME RACK COATINGS**

☆**UNICHROME STOP-OFF LACQUERS AND COMPOUNDS**

☆**UNICHROME Clear and pigmented LACQUERS**

☆**UCILON**—corrosion-resistant coatings for protecting surfaces against acids, alkalies, water, gasoline and various corrosive chemicals.

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VAN DORN WELDMENT

● Ruggedness . . . Adaptability . . . Economy . . . Modern Design . . . are outstanding features of welded structures designed and built by Van Dorn.

Weldment designers of exacting experience . . . fabricating facilities for every requirement . . . skilled and highly trained workmen . . . are combined at Van Dorn to supply engine and machine builders better bases and frames of welded construction.

Builders of better iron and steel products for 75 years

THE VAN DORN IRON WORKS CO.

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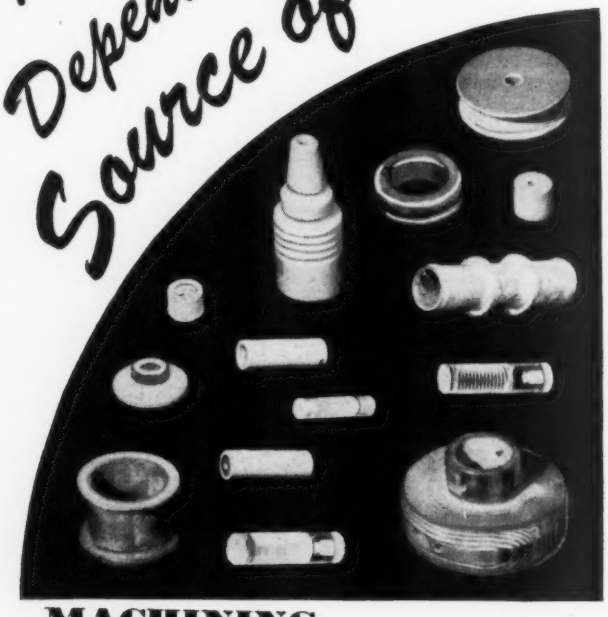
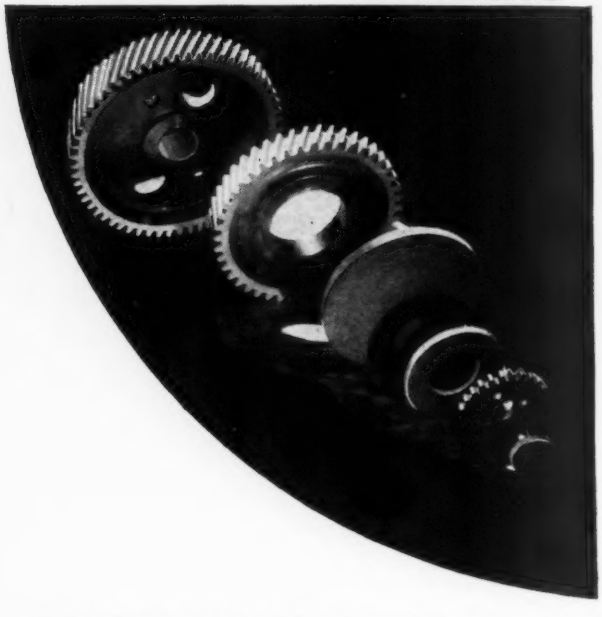
Here's a Dependable Source of FABRICATED PLASTIC PARTS



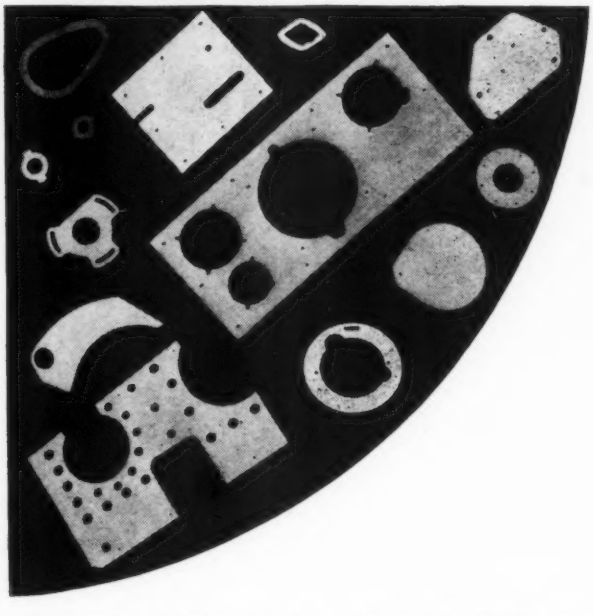
MACHINING

FORMING

HOBBING



PUNCHING



● Our business is the fabrication of plastic parts and products, exclusively. We have access to the latest and best sources of all types of laminated, cast and molded plastic materials for almost every application. We fabricate these materials from sheet, rod and tube stock, by machining, punching, forming, hobbing, etc.

● Accurate fabrication has characterized all our war-production for many of the nation's largest buyers. Recently, our facilities were greatly increased. We can produce long or short runs, making early, on-schedule deliveries of plastic parts and products of simple or intricate design. For prompt quotation, send prints, specifications and samples.

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McINERNEY Plastics Co.

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Replacing Critical Materials *with* ACADIA *Synthetic Products*

If a scarcity of urgently needed materials delays your production, this may be the answer to your problem: parts cut, molded, or extruded from Acadia Synthetics which incorporate the essential qualities for the job.

Acadia Synthetic Products can be processed to close tolerances—in any shape, or size desired—compounded to meet specific conditions. Name the characteristics required—elasticity, plasticity, resilience, etc.—and our engineers will suggest the right material.

Write, wire or phone today.

ACADIA *Synthetic* **PRODUCTS**

DIVISION OF WESTERN FELT WORKS

Processors of Synthetic Rubber and Plastics
Sheets • Extrusions • Molded Parts

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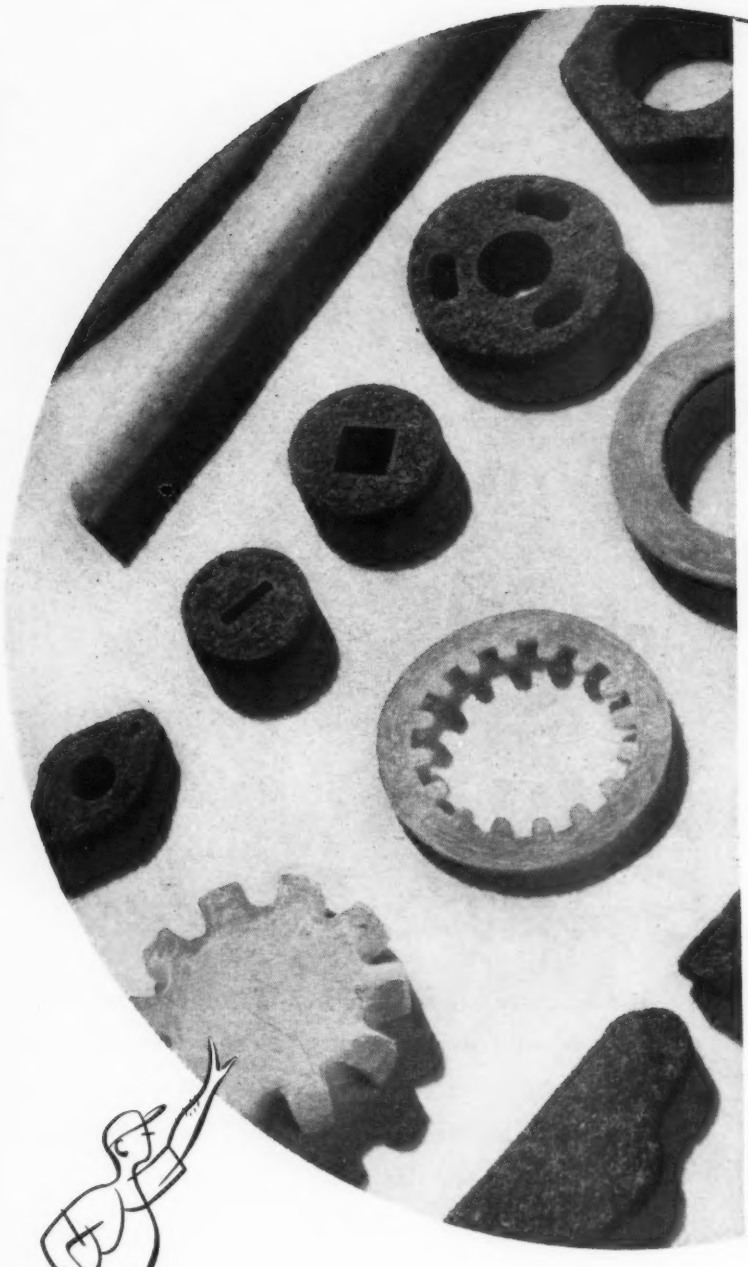
LARGEST INDEPENDENT MANUFACTURERS AND CUTTERS OF FELT



Why You Should Go to FELTERS for Your Cut Felt Parts

From the raw material stage to the precision cutting operations, *every* step in the manufacture of Felters Cut Felt Parts is under the complete control of The Felters Company. The advantage to the consumer of this start-to-finish supervision is reflected in the quality, uniformity and accuracy of every part that leaves The Felters Company mills.

Many of the cutting machines used are of Felters own design and manufacture, embodying the results of years of felt cutting experience. Felters makes its own dies, thus assuring control of accuracy, availability and cost—is equipped to fabricate parts into any shape or size.

Felters precision cutting means less waste, less cost and *accurate* parts to speed your assemblies.

And rapid, reliable deliveries of Felters Precision Cut Felt Parts make it easier for you to plan your production with minimum inventories.

New Felters manual makes ordering of cut felt parts quick and easy. Send for your copy today.

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. . . JUST A KID!

He could skip school for fishin' . . . He could sneak home with trousers torn . . . Scuff up his shoes . . . Be late for meals . . . Or lose his best pair of mittens . . . Somebody always said it . . . "Just A Kid."

A little young to know what's right . . . The same things happen time and again . . . It's the hard way to learn—through experience—but it's the sure way . . . Looking back, all of us can remember when—"Just A Kid"—meant us . . . It's experience that has helped us up the ladder . . . Experience in a lot of things . . . Right and Wrong, Good and Bad, Old and New, Work and Play, Business and Pleasure.

There'll be more to come . . . We at Wolverine are proud of the road we've traveled . . . The things we've learned, and the experience we own today . . . Proud of our parent company, Calumet & Hecla . . . Their long and successful career and the guidance they have afforded us . . . Each of us has learned as a person, and together as a Division . . . Constantly striving, as today, for new and better ways to improve our products and to help our customers.

When you need Seamless Copper or Brass Tubing—call on 29 years' experience . . . Send your specifications to Wolverine.

WOLVERINE TUBE DIVISION
Calumet & Hecla Consolidated Copper Company
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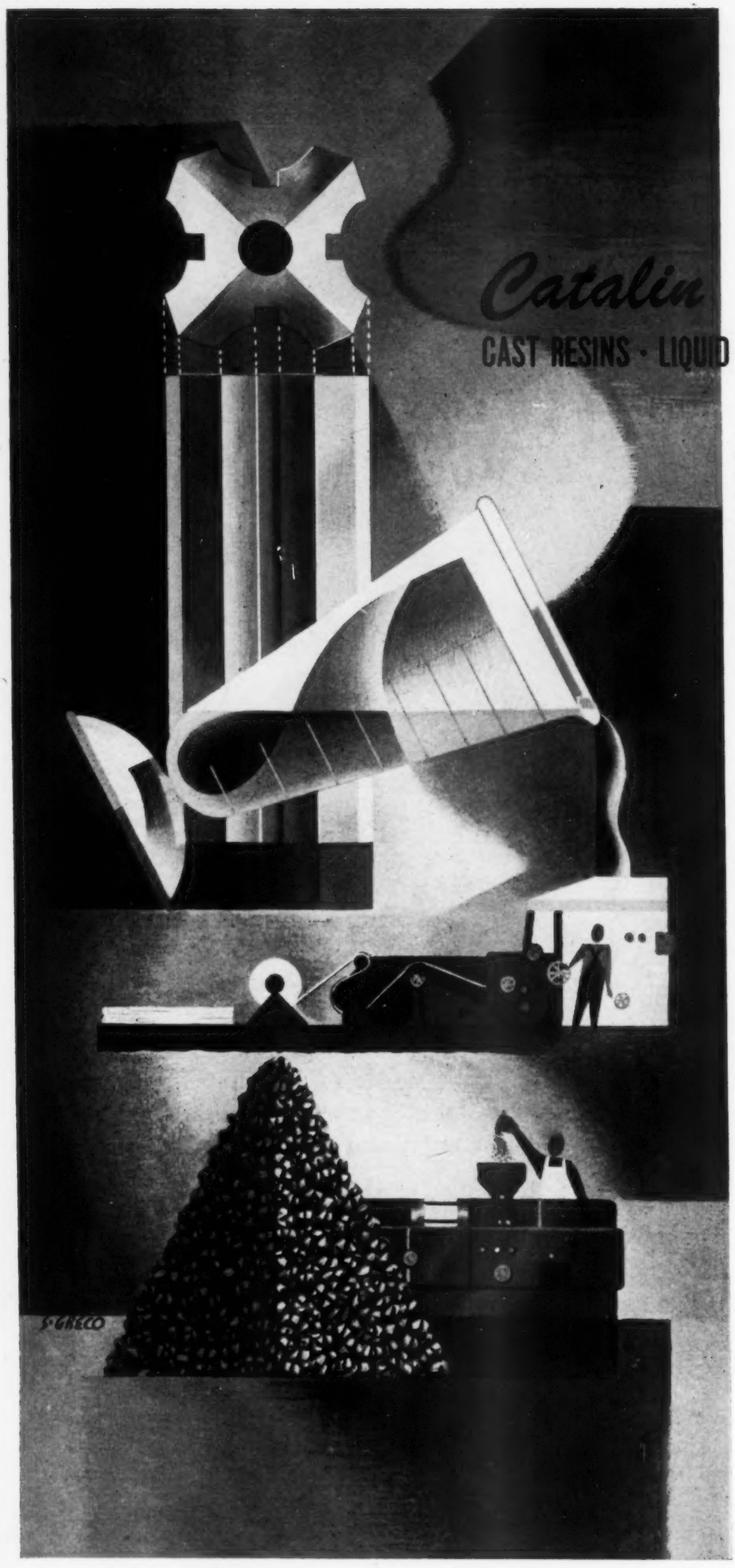

CAST RESINS · LIQUID RESINS · MOLDING COMPOUNDS

. . . Each type is sub-divided and classified into many formulations. All were developed to meet specific functional or decorative requirements.

CAST RESINS . . . "Catalin" and "Prystal" cast phenolics in sheets, rods, tubes, shapes, are available in a limitless range of gem-like colors. These plastics fabricate as easily as brass or hardwood. Tools for special designs can be quickly and inexpensively produced.

LIQUID RESINS . . . "Catabond", "Catavar" and "Loabond" are employed in coating, laminating, glueing, bonding and impregnating various materials such as wood, plywood, abrasives, leather, paper, etc.

"Catalin Casting Resins" are used in producing low-cost tools for the fabrication of aluminum sheets. They also excel as drill and saw jigs, router, shaper and hydroform blocks, checking fixtures, stretch press molds and dies—particularly those involving contours.

MOLDING COMPOUNDS

Thermoplastic . . . "Loalin" polystyrenes possess outstanding electrical, chemical, thermal and mechanical properties; are dimensionally stable, light in weight and low in cost. Available in a broad range of colors.

Thermosetting . . . "Catapak"—for compression molding. Meets low-cost, high-impact strength requirements.

Upon request, the members of Catalin's technical staff will be very glad to direct their plastics know-how to your problems or plans.

CATALIN CORPORATION
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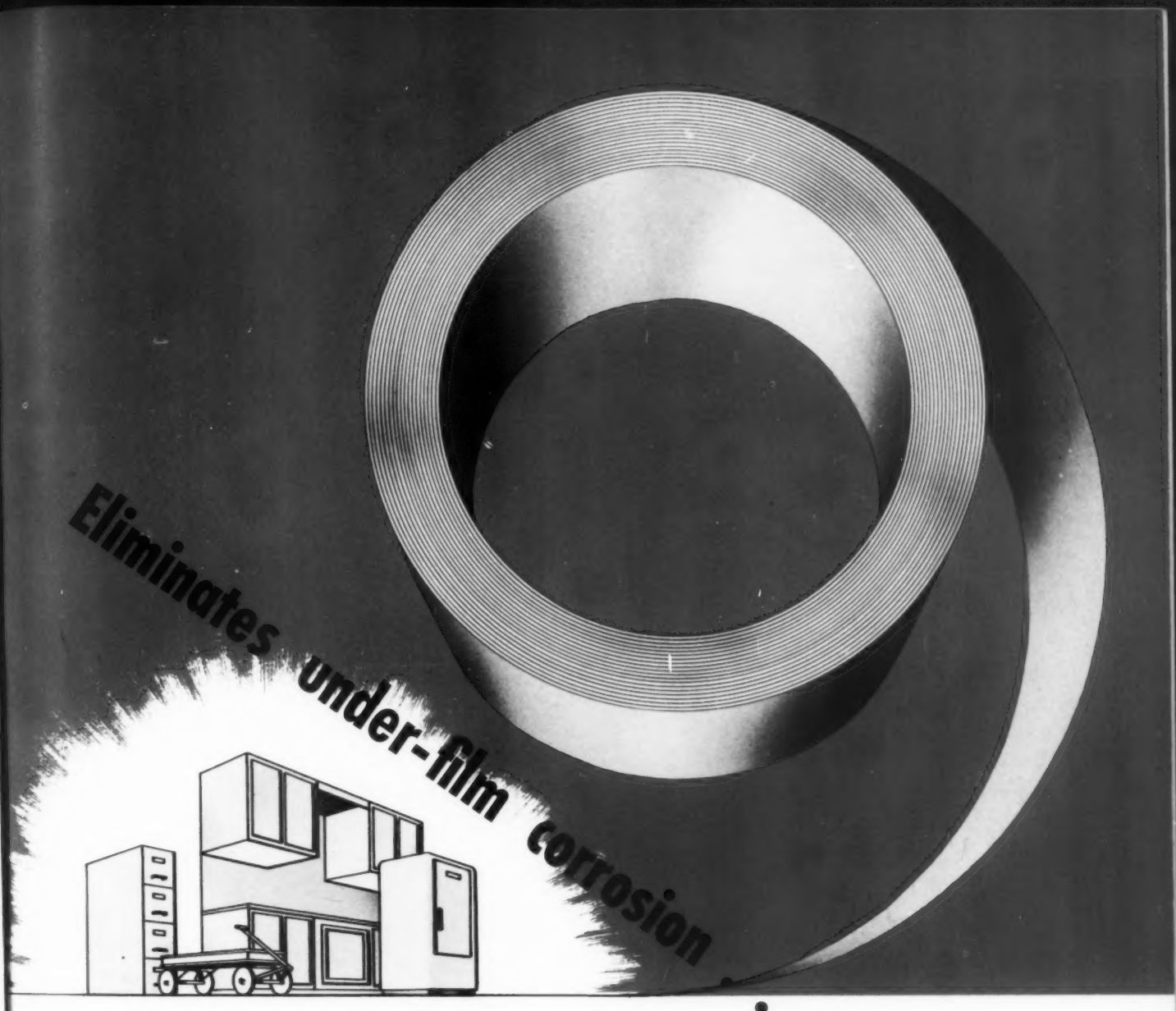
Catalin



Weirzin

ELECTROLYTIC ZINC COATED SHEETS AND STRIP

The paintability of Weirzin is a *double feature.*

First, the superior surface of Weirzin serves as a primer coat and provides a better "tooth" for paint, enamel, varnish, lacquer or lithograph inks by either spray, dip or roller application.

Second, the exceptional rust resistance of Weirzin makes it immune to high temperature and humidity and positively prevents under-film corrosion.

Paintability is just one of the many substantial advantages you enjoy when you use Weirzin. It's your answer to a better product at a lower net cost.

Write for a test sample and a copy of our new technical bulletin *and prove it to yourself.*

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WEIRTON, W. VA. *Sales Offices in Principal Cities*

Division of **NATIONAL STEEL CORPORATION** *Executive Offices, Pittsburgh, Pa.*

Welded Design does it again!

...reduces cost...saves metal ...speeds production

This metal-working plant's problem was to find a production method that would speedily turn out a large number of aluminum canteens they had on order for the armed forces — without raising production costs.

For the solution — the company turned to oxy-acteylene flame welding. Ten identical jigs of unique design were devised . . . each jig to require the full time operation of 3 girls — one to flux enough canteens to keep the other two busy doing the actual welding.

Each half of the canteen is made as an aluminum stamping provided with a small flange. These flanges are butted together and fused to form the weld, eliminating filler rod. The illustration above shows one jig with its 3-girl welding team in action.

This is but one of the many broad design possibilities made possible by welding. Where product design calls for light weight, durability, plus a strength equal to or greater than the parent metal itself — welded construction meets the specifications. Furthermore, welding saves metal — speeds production at lower costs, and makes for finer finishes.

Industrial designers are invited to consult with Airco's Applied Engineering Department for further information on the many favorable design possibilities of the oxyacetylene flame or the electric arc. For an appointment, call your nearby Airco office today, or write: Dept. P D, Air Reduction, General Offices: 60 East 42nd Street, New York 17, N. Y. In Texas: Magnolia Airco Gas Products Company, General Offices: Houston 1, Texas. Represented internationally by Airco Export Corporation.

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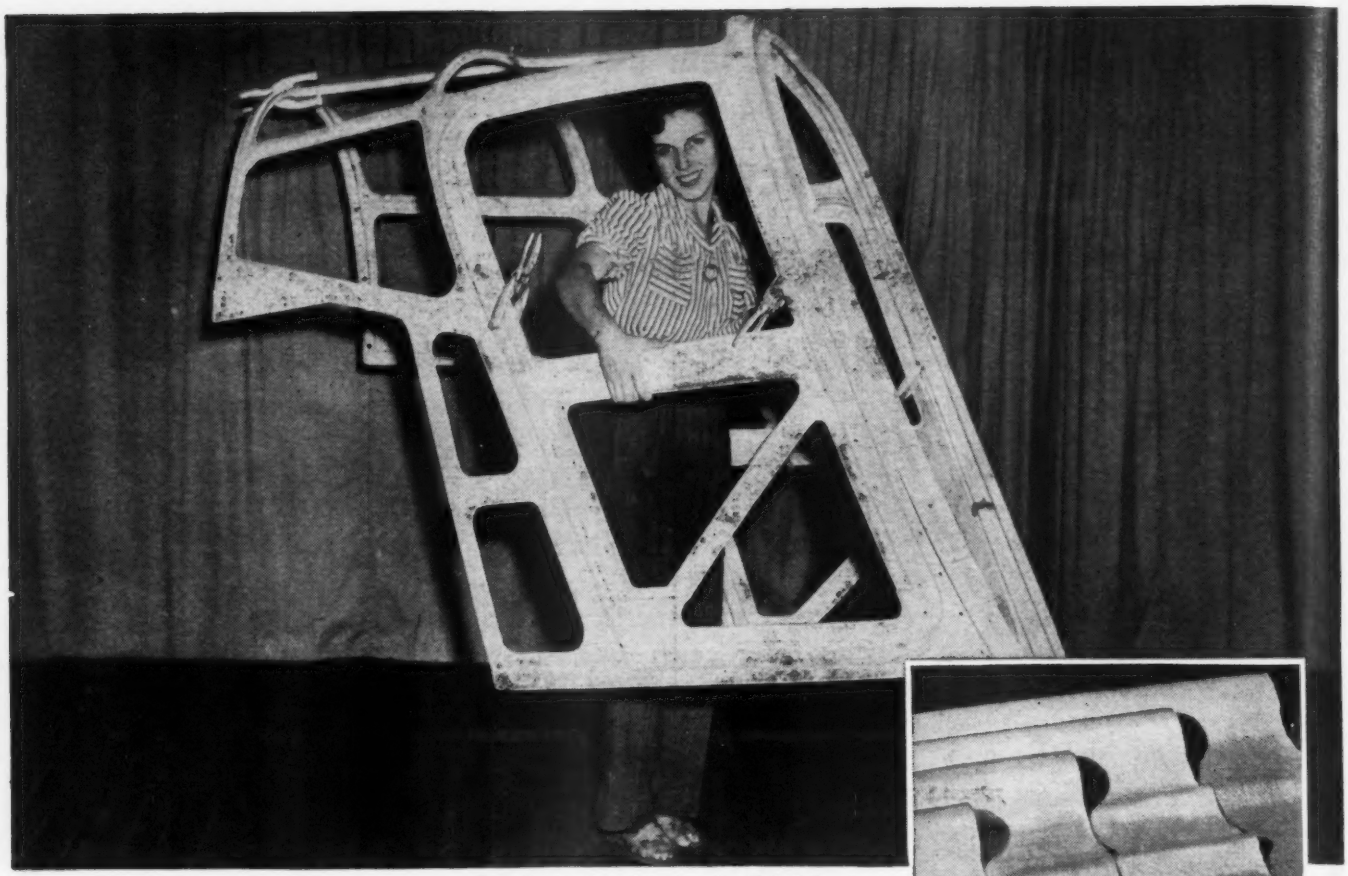


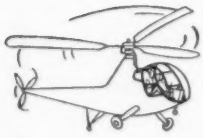
Fiberglas-plastics fabrications by United States Rubber Company for Nash-Kelvinator Corporation.

Fiberglas—glass in the form of fine fibers—twisted into yarn and woven into cloth, possesses many of the properties most sought after in low-pressure laminates.

FIBERGLAS*– REINFORCED PLASTICS

—a spectacular, new, lightweight

Structural Material

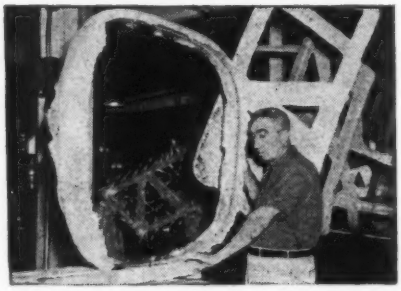


Aircraft structural parts, such as the cabin structure of the Army R-6 Helicopter, are now being made of plastics reinforced with Fiberglas — fine filaments of glass woven into cloth, then used with low-pressure resins in the fabrication of extremely strong, lightweight laminated plastics parts.

Fiberglas textiles are resistant to moisture, therefore are dimensionally stable. They possess great tensile strength, and are resistant to heat, oils, corrosive vapors and most acids.

The combination of Fiberglas and certain low-pressure resins has resulted in a material with properties which excel those of any material previously available for commercial use. For example, impact strength from five to ten times that previously obtained in laminates is now attained through Fiberglas reinforcement. Higher strength-to-weight ratios, greater rigidity, dimensional stability and simplified fabrication are but a few of the advantages which are resulting in the rapidly increasing use of Fiberglas for reinforced plastics sheets and formed parts.

Samples and complete information on Fiberglas Textiles will be sent to you on request. Owens-Corning Fiberglas Corp. does not manufacture resins or finished laminates but will be glad to furnish data on techniques in the use of Fiberglas and low-pressure resins. Write: *Owens-Corning Fiberglas Corp., 1878 Nicholas Bldg., Toledo 1, Ohio. In Canada, Fiberglas Canada Ltd., Oshawa, Ont.*



R-6 cabin structure of Fiberglas-reinforced plastic being trimmed and made ready by U.S. Rubber for shipment to Nash-Kelvinator.

The R-6 Helicopter which will be used to transport wounded from inaccessible combat areas and will service military outposts with supplies.

ARMY E NAVY

FIBERGLAS .. A BASIC MATERIAL

*T. M. Reg. U. S. Pat. Off.

In Transportation • In Industry • In the Air

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For a Wide Variety of Uses

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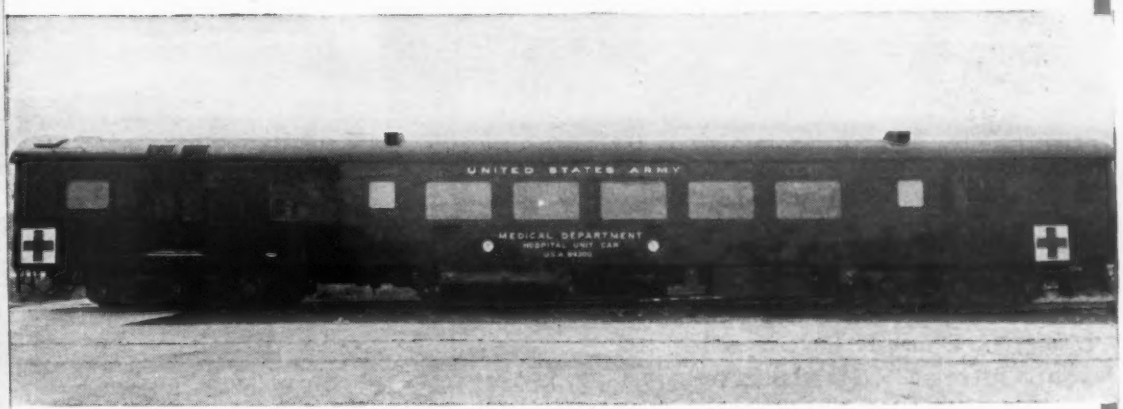
Our Engineering, Technical, and Laboratory facilities are at the service of any industry with a sealing problem.

Widely known for their use in many fields, Presstite Sealing Compounds are finding many applications in railroad car construction. For example, in the Army's newest type hospital cars built at the St. Charles, Missouri, plant of American Car & Foundry Company, Presstite No. 500 Adhesive Felt Tape is used as an insulation against frost and as an anti-squeak and sound deadener. Presstite Permagum tightly seals and seats such equipment as toilet bowls, and Presstite Enamelite bonds and seals the insulation of the refrigeration and cooling systems.



ACF-Built Hospital Car for Army Transportation Corps.

Presstite No. 500 Adhesive Felt Tape being applied as anti-squeak and sound deadener

Other Presstite sealers and adhesives that assure better sealing, more economical car construction and maintenance, include: No. 23212 Extruded Glass Sealer, No. 2390 Asphalt Rustproofing Mastic, Nos. 504 and 505 Impregnated Adhesive Felt Packing and Presstico Spot Weld Sealer.

To all industry, Presstite offers superior sealing compounds that have met the stringent testing of wartime applications, as well as a long record of industrial uses for over a quarter century.

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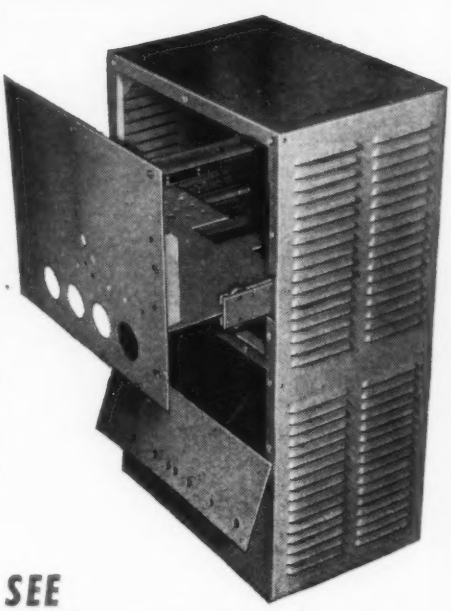
THAT IS WINNING THE WAR!

From custom electric signs and theatre marquees, to conveyor line production of radar cases! This is the story of Donnelly Electric and Manufacturing Co. (Division of Donnelly Advertising Co., Boston) contribution to victory!

Plans were made for top production. Equipment was selected and space was utilized with this goal in mind. Handling operations and time between operations had to be minimized. The finishing system we recommended is a progressive, two-handling, continuous operation. Parts are hung on conveyor and pass through priming booth. Berry Brothers' No. 10 Ferrochrome Primer is applied and the parts then travel seven minutes to the enamel booth.

At the entry to this booth, the first coat of Berry Brothers' Infrabake 4.5 Gray Semi-Gloss Enamel is applied. The parts then travel five minutes to the next spray station and the second coat of enamel is applied. Then they go through the infra red unit for seven minutes, and to the shipping department.

Without products tailored to fit the required timing, a longer conveyor, more floor space and less production would have resulted. This same "Know How" is available to you. Write for further information.



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ARMY E NAVY

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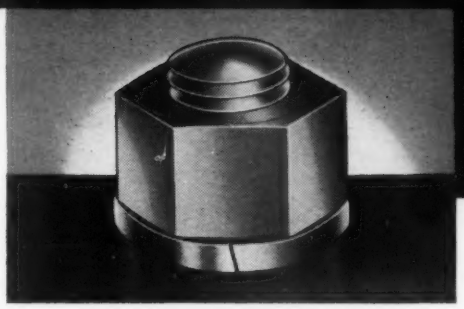
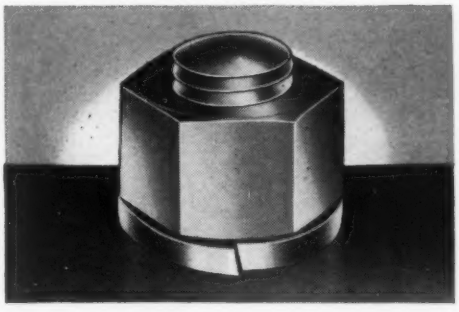
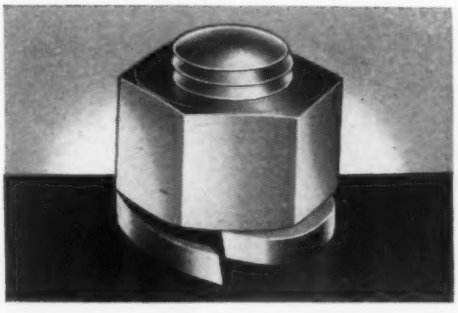
SPRING LOCK WASHER PRESSURE HOLDS IT TIGHT!



WRENCHED TIGHT



NORMAL WEAR — STILL TIGHT

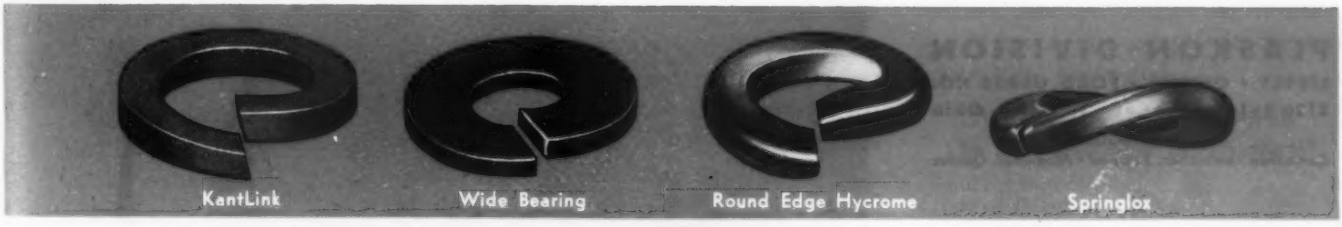


RELEASED HALF TURN — STILL UNDER TENSION

The additional thread friction, plus the reactive pressure constantly exerted under the head of bolt, screw or nut keeps assembled parts tight in spite of looseness resulting from wear. Wrenching tight of the nut on an assembled part builds up the Spring Power of the Spring Lock Washer which exerts that all important pressure.

Illustrated is the KantLink Spring Lock Washer which has many industrial uses. Round edge Hy-Crome for use on heavy duty machines and farm equipment. Wide Bearing is used in place of a flat washer but has the additional advantages of the Spring Lock Washer. Springlox, a thin section tension washer for use in the aeronautical field and on short bolts and screws where stronger tension is desired.

Write on your letterhead for our descriptive Lock Washer Folder No. 142.



Eaton Springtites — the all-in-one units — cut production costs by increasing production efficiency. Write for folder #101.

Snap, bearing, lock retainer rings are used on shafts, in counter bores, and on outer races of bearings. Cuts production cost—saves time and material. Write for Engineering Folder No. 43.

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Sun Helmets —fighter style

The exceptional characteristics of Plaskon Resin Glue are utilized in the production of sun helmets for armed forces in the tropics.

No ordinary glue will permit the fabrication of helmets that are so light, so strong, so weatherproof. The holding power of Plaskon Resin Glue is practically indestructible. It is highly resistant to the effects of water, even when immersed for periods of time. No mould, fungi or bacteria can attack it. Extremes of heat and cold cannot affect it. In hot, steaming jungles and torrid deserts of tropical zones, these Plaskon Resin Glue features of permanence are especially important.

The rain-shedding helmet at the top is molded in one piece from cork and fabric, glued together by Plaskon resin into one integral unit that cannot delaminate or separate. The fair-weather helmet at the bottom also is molded in one piece, from mesh-weave fabric that has been coated with Plaskon resin. Rigidity is given both these helmets by the strength of the resin glue after molding.

This is another illustration of the new gluing and bonding advantages which Plaskon Resin Glue is bringing to a wide range of industries. Wood, paper, fabrics, glass cloth, compositions—almost all kinds of porous materials can be *permanently* bonded together and strengthened with this remarkable product of resin research. Plaskon facilities and experience are available for planning the adaptation of Plaskon resins to your present and future manufacturing and sales plans.

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★ RESIN GLUE ★

How to make BIG plastic parts seem LITTLE

Radio cabinets, housings, washing machine agitators and such—all the larger and more complicated pieces we used to mold before the war—all will go on the production schedules of smaller, simpler pieces when we get into normal production again. They will have better finishes, more uniform cure, truer color and freedom from internal stress. In other, shorter, words, "Happy Day!"

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Better start figuring now on how Plastics plus Heatronics can fit into *your* postwar production plans. But figure it with a custom molder whose reputation for molding already combines with real Heatronics knowledge —a molder like Kurz-Kasch. We mold all materials by compression and transfer—we handle the whole job from design to delivery—our experience with Heatronics dates back to the first unit RCA sold—and we've been growing with the plastics industry since it began.

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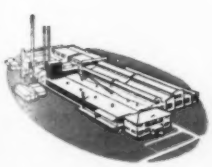
"A Businessman's Guide to the Molding of Plastics"

Send for your free copy of this illustrated brochure. Just write to Dept. 7 on your letterhead and we'll send it with our compliments.

Kurz-Kasch



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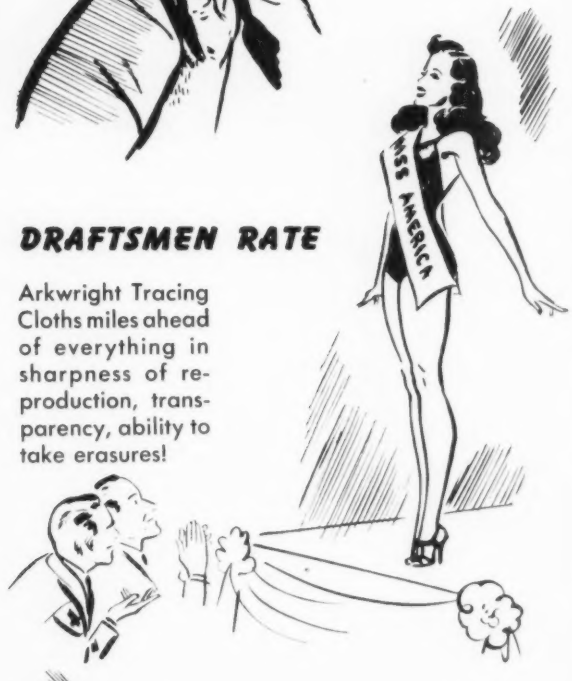
—there isn't a tracing paper made that can hold a candle to Arkwright Tracing Cloths!



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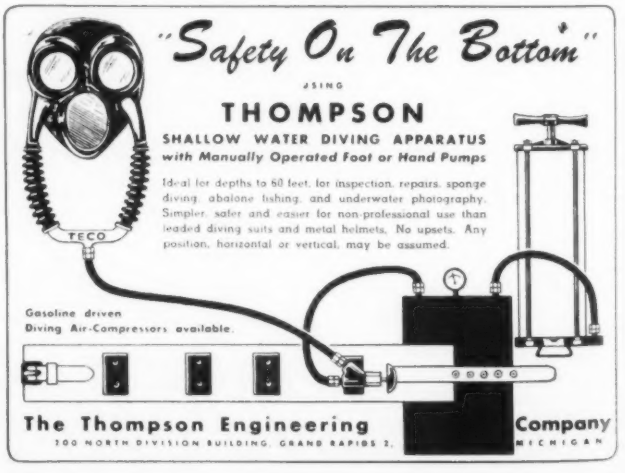

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The Thompson Engineering Company
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The fighting war is half over but the necessity for Panelyte production for Victory is *greater* now than it has ever been.

We have been assigned an "Approved" Quality Control Rating by the Air Technical Command, which abolishes the need for official Army Air Forces product inspection and acceptance. We have assumed full responsibility for the excellence of Panelyte molded and fabricated parts required. And, we are shooting for another "star" in our Army Navy "E" Flag.

However, we will *make* time to discuss with you *now* the design and mass production of molded and fabricated parts so that no time will be lost getting into civilian production. We are fortunate in that no reconversion is necessary in order to start peacetime industrial production. Your inquiry will have prompt attention.

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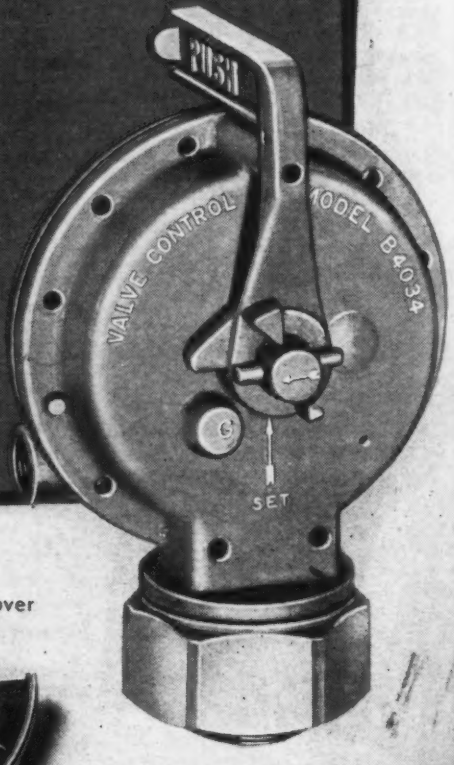
"Fire Wardens" that are DIE CAST

Alert guardians against ever-present danger of fire in planes and tanks! The flame detector spots the fire . . . then, a quick flip of the manual control releases flame-smothering carbon dioxide.

Mt. Vernon die casts the parts for both of these intricate assemblies for Walter Kidde and Company. Production of these essential safety items is but one of many instances wherein Mt. Vernon skills serve industry today. Those same abilities are ready to serve you, too!



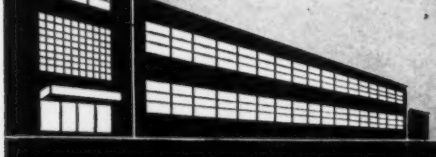
Manual Handle with automatic stops cast

Universal Fitting

Housing Cover

Cam and Pulley in one casting

Main Housing



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MEEHANITE *makes it possible!*

NEW SLIDE VALVE DESIGN PROVIDES IMPROVED PERFORMANCE

Electrol, Inc., Kingston, N. Y., recently designed a new hydraulic valve for use in fighter aircraft to aid in the control of the Auto-Pilot. After considerable experimentation it was found that a Meehanite spacer forming the valve seat and slide support permitted maximum successful operation of the unit.

The dense, uniform structure of Meehanite containing finely dispersed graphite particles (a structure controlled by Meehanite manufacturing processes) provides a fine self-lubricating bearing surface for a carburized and hardened steel slide. Three rubber O-rings are used to fit the spacer in the aluminum housing, permitting the use of aluminum, steel and Meehanite in close conjunction despite different coefficients of expansion.

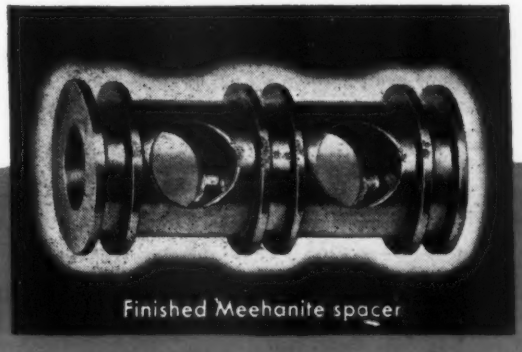
The unit has made it possible to hold the pressure drop to about one pound at three gallons per minute flow.

From a manufacturing standpoint the uniformity and machinability of the Meehanite Castings also contributed to reduce production costs.

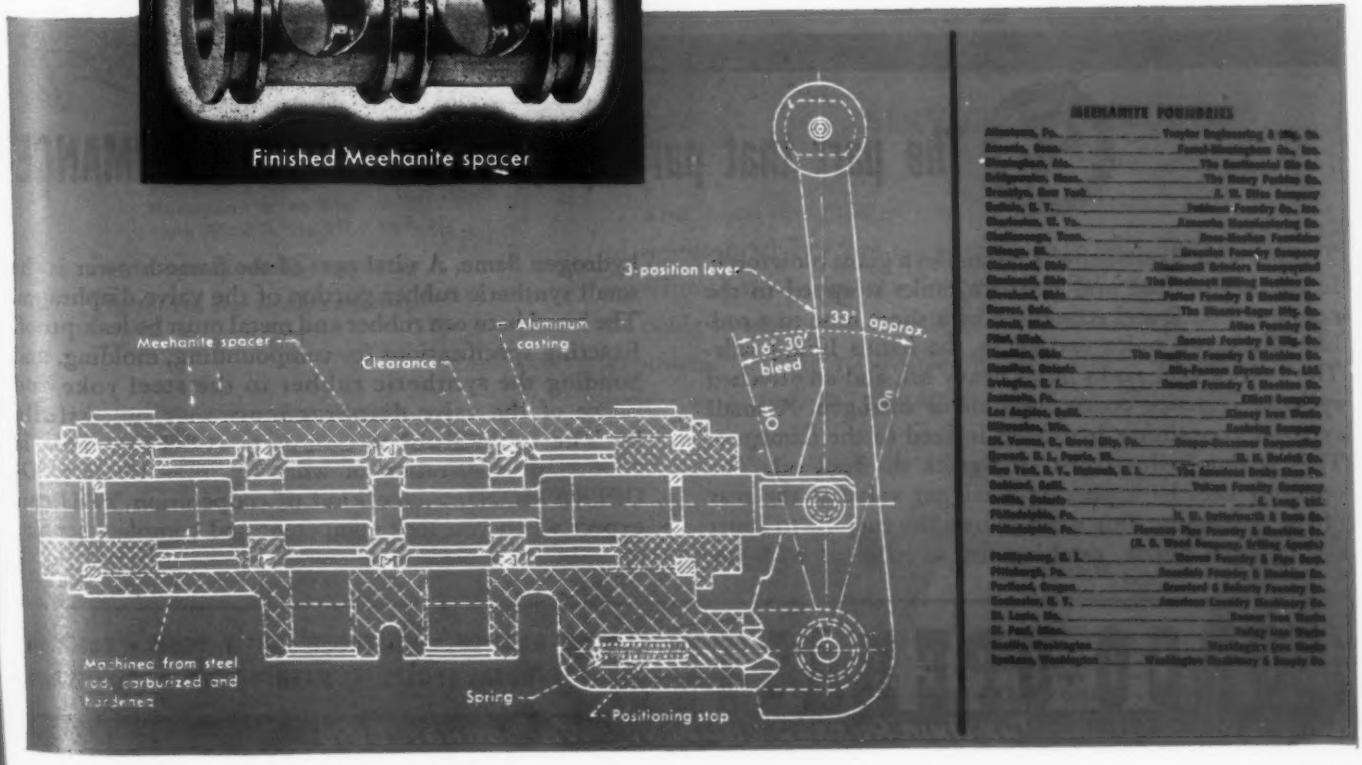
IN NEW PRODUCT DESIGN THE TREND IS TO MEEHANITE!

Write for Bulletin No. 18
"Meehanite—the Metal for Post-War Castings."

MEEHANITE RESEARCH INSTITUTE
NEW ROCHELLE, N. Y.



Finished Meehanite spacer



MEEHANITE FOUNDRIES

When the stubborn enemy in a foxhole or pillbox resists the blasting of heavy guns, Chemical Warfare Service flamethrowers go into action while riflemen cover the position to keep down enemy fire.

U. S. Army Signal Corps Photo

Helps Flame Throwers Throw Taps

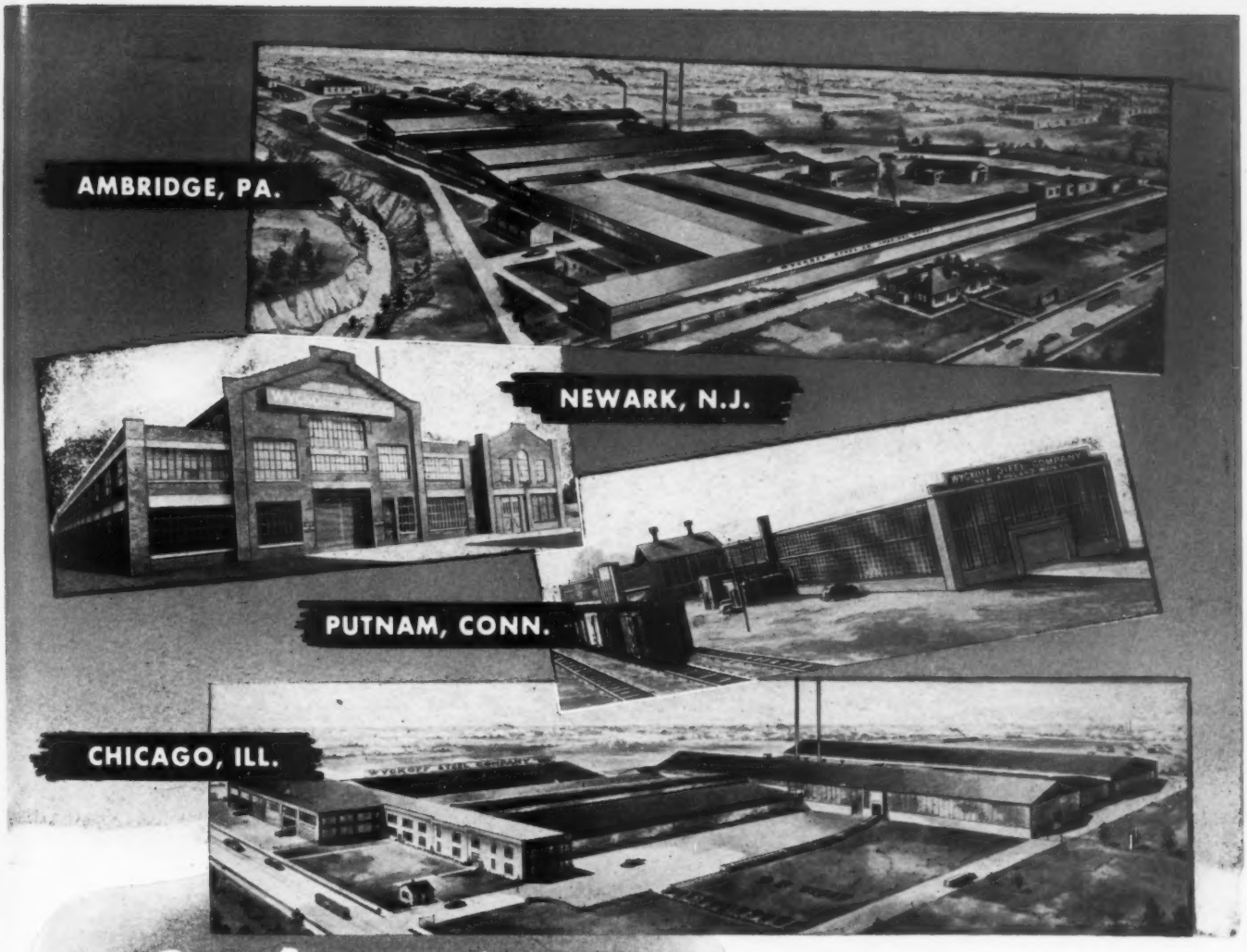
The part that parts play in PRODUCT PERFORMANCE

The portable flamethrower resembles a giant blowtorch. It consists of fuel and pressure tanks strapped to the operator's back and connected by a short hose to a rod-like discharge piece carried in the hands like a rifle. The pair of fuel tanks holds heavy oil, and an attached cylinder contains compressed air or nitrogen. A small cylinder containing hydrogen is fixed to the flamegun. This is the "pilot-light" to ignite the fuel oil. The operator fires by squeezing a trigger valve at the rear of the flamegun. This valve allows the fuel oil to spurt through the nozzle, catching fire as it mixes with the hydrogen flame. A vital part of the flamethrower is the small synthetic rubber portion of the valve diaphragm. The bond between rubber and metal must be leak-proof. Exacting specifications for compounding, molding, and bonding the synthetic rubber to the steel yoke and sleeve of the valve diaphragm are met successfully by The Ohio Rubber Company (ORCO). This is another demonstration of what we mean by "ORCO-OPERATION". . . the kind of cooperation YOU can expect when you seek competent and complete service on rubber requirements.

"ORCO-OPERATION"

BRANCHES: DETROIT • NEW YORK • CHICAGO
INDIANAPOLIS • WASHINGTON • CLEVELAND

THE OHIO RUBBER COMPANY · WILLOUGHBY, OHIO



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COLD FINISHED STEEL PRODUCTS

★ Carbon and Alloy
Rounds ⅛" to 6"
Squares ⅛" to 4"
Hexagons ⅛" to 3⅞"
Flats ⅛" x ¼" to 2" x 12"

★ Turned and Polished Shafting

★ Turned and Ground Shafting

★ Special Sections

With unexcelled furnace facilities for producing a complete range of sizes and treatments.

FROM 1 to 4

***. . . because of constant adherence to the highest standards of* QUALITY, ACCURACY *and* SERVICE TO INDUSTRY**

. . . and when the guns of war are silenced, a network of representatives from coast to coast, with complete warehouse stocks in every large industrial center, will be ready to serve your *every* need for cold finished steel products. In the meantime, let Wyckoff engineers work with you, in planning for those *cost-saving* days to come.

ARMY ★★ NAVY

WYCKOFF STEEL COMPANY
FIRST NATIONAL BANK BUILDING · PITTSBURGH 30, PA.
3200 S. KEDZIE AVENUE, · CHICAGO 23, ILLINOIS

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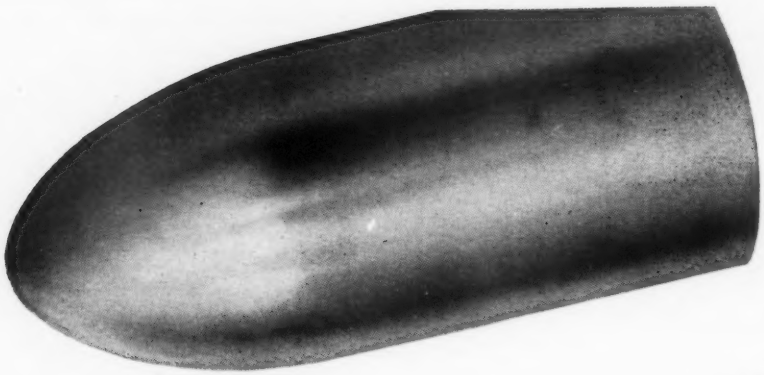
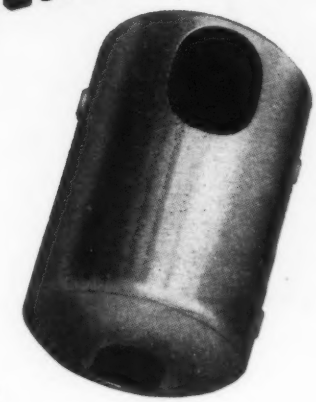


CAN YOU FIND THE FAMILY RESEMBLANCE?



● It would be a fruitless search . . . if you consider appearance alone. But look deeper . . . into the advantages they afford for many users. You'll see why these shapes and shells are all one big family.

They are all deep drawn by the Hackney Process, resulting in smooth finish, uniform thickness and temper. Ask users about them. One can tell you how they decreased the over-all weight of a product. Another can point how his product's strength was increased. In other cases appearance was improved, costs reduced, production speeded up and durability increased. Often a combination of these advantages has been realized.

Pressed Steel Tank Company, specialists in the manufacture of deep-drawn seamless shapes and shells for over 40 years, has made them in capacities as small as one quart and as large as 150 gallons. Perhaps a Hackney Deep-Drawn Shape or Shell can help you in your production problem. Send us blueprints and available data. Of course, there is no obligation.

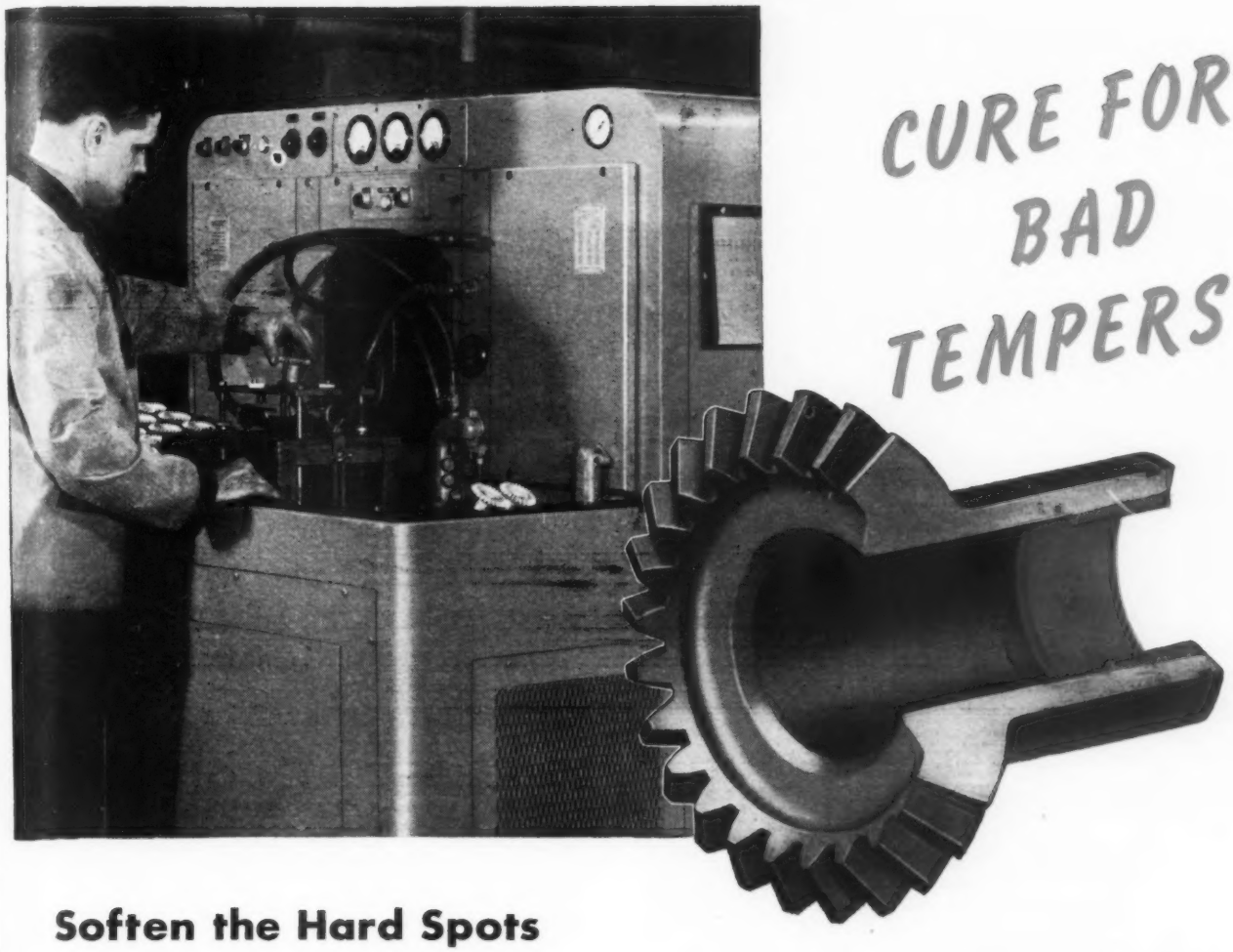
Hackney MILWAUKEE

Pressed Steel Tank Company

Manufacturers of Hackney Products

1312 Vanderbilt Concourse Building, New York 17
208 South La Salle Street, Room 2082, Chicago 4 — 565 Roosevelt Building, Los Angeles 14
1434 South 66th Street, Milwaukee 14, Wisconsin

CONTAINERS FOR GASES, LIQUIDS AND SOLIDS



CURE FOR BAD TEMPERS

Soften the Hard Spots

... Eliminate Tool Breakage with the TOCCOTRON

NASH-KELVINATOR, Aircraft Engine Division offers this suggestion to shop executives who are vexed with the tool-breakage bogey.

Anneal the portion of the part to be machined. Do this by TOCCO Induction Heating. This localized annealing does not disturb the hardness of other portions of the part. Results for a number of their aircraft engine parts: breakage of expensive broaching tools and resultant delays are now nil. The gear illustrated, for example.

Leakage of the carburizing gas through the copper-plating on the inner surface resulted in hard spots when whole piece was carburized and hardened. When splines were cut, tools often broke.

Now . . . that area for a depth of .025-.040 inch is heated to 900-1000° F. with a 20 K.W. TOCCOTRON. Heating time is 2 seconds. The part is then cooled by an integral quench to facilitate handling. Total treating time per part is only 3.4 seconds. The uniformity of this localized induction heating assures perfect results on every part.

Find out how the new TOCCOTRON (Electronic Tube model) or TOCCO (Motor-Generator models) can help solve *your* problems of war production and postwar planning. "Results with TOCCO", Bul. 14, gratis.

THE OHIO CRANKSHAFT COMPANY · Cleveland 1, Ohio

TOCCO

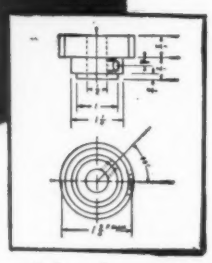
INDUCTION

HARDENING, BRAZING

ANNEALING, HEATING

and our print requirements are too large for a small-capacity machine, yet we don't want to invest in expensive, high-volume equipment which would give us a lot of waste capacity. Is there a medium priced printer-developer for medium quantity requirements?

.....Here's your answer: New BRUNING Model 41 Printer-Developer



• If you belong to the 60% of all print users who require prints in medium quantities, here's exactly the machine you need! The new Bruning Model 41, for making BW Black and White Prints, combines both printer and developer in a single, compact, attractive unit . . . to give you fast, efficient print production at moderate cost.

With an actual printing and developing width of 46 inches, the Model 41 exposes and develops Black and White Prints from roll stock or cut sheets up to six feet per minute. A brilliant new 2000 watt glass mercury lamp assures uniform distribution of light. An improved method of cooling is used to assure uniform cylinder temperature, resulting in uniformity of print exposure—plus greater operator comfort. A new type ironing roll produces smooth, flat, dry prints. And like all Bruning Printer-Developers, the Model 41 is exceptionally easy to use—requires no plumbing connections. With this machine, even inexperienced operators can turn out clean, perfect prints.

•

Let us give you complete facts about the Bruning 41 Printer-Developer—or about other Bruning equipment for every print need. Mail the coupon!

It's positively right—in Bruning Black and White

CHARLES BRUNING COMPANY, INC.
4736-50 Montrose Avenue, Chicago 41, Illinois
Please send me complete information on your Model 41 Printer-Developer—and on other Bruning printing and developing machines for making Bruning Black and White Prints.

Name .....

Company .....

Street .....

City ..... *State* .....

CHARLES BRUNING COMPANY, INC.
Since 1897

NEW YORK	CHICAGO		LOS ANGELES
Atlanta	Boston	Detroit	Houston
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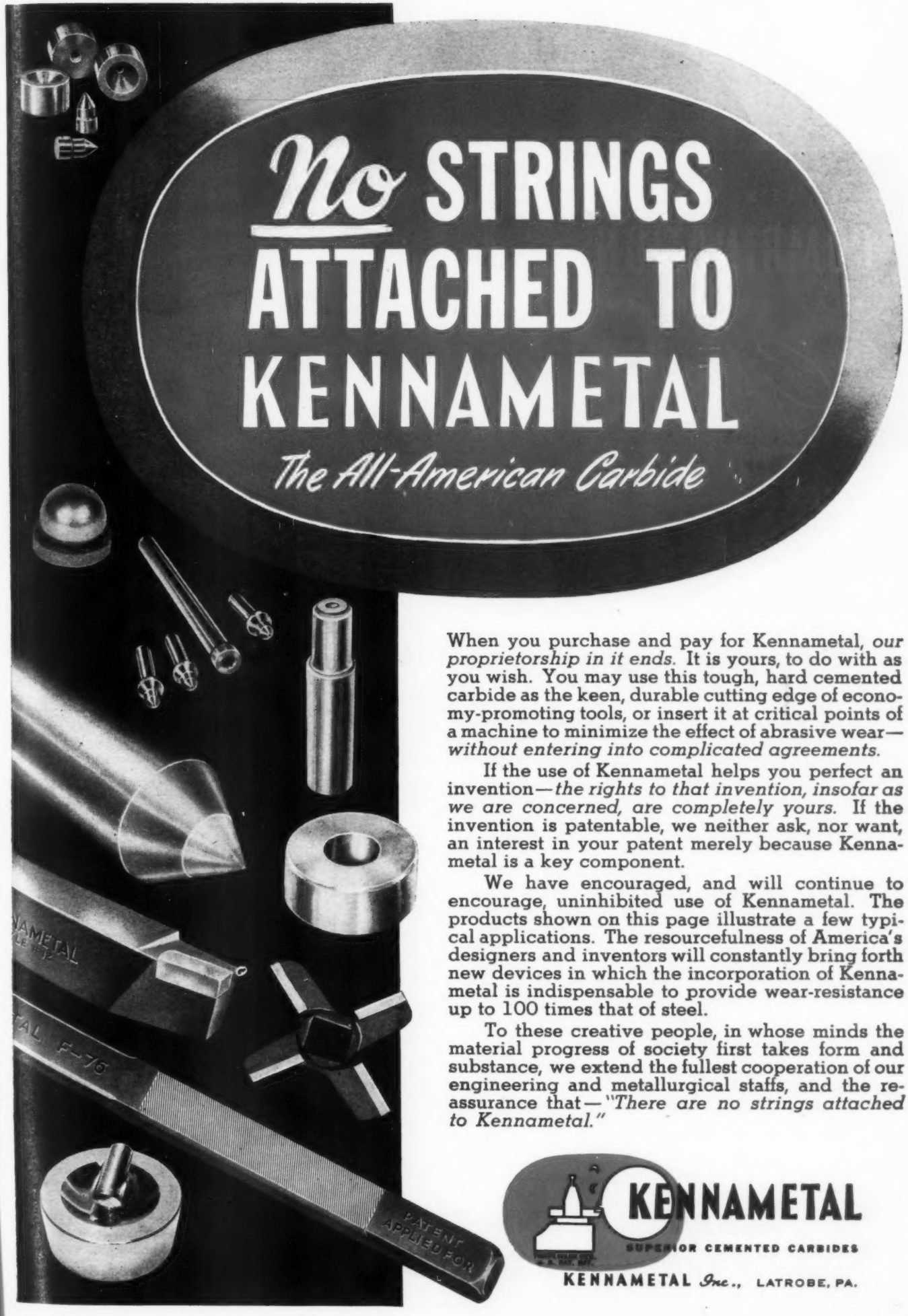


When you purchase and pay for Kennametal, *our proprietorship in it ends.* It is yours, to do with as you wish. You may use this tough, hard cemented carbide as the keen, durable cutting edge of economy-promoting tools, or insert it at critical points of a machine to minimize the effect of abrasive wear—*without entering into complicated agreements.*

If the use of Kennametal helps you perfect an invention—*the rights to that invention, insofar as we are concerned, are completely yours.* If the invention is patentable, we neither ask, nor want, an interest in your patent merely because Kennametal is a key component.

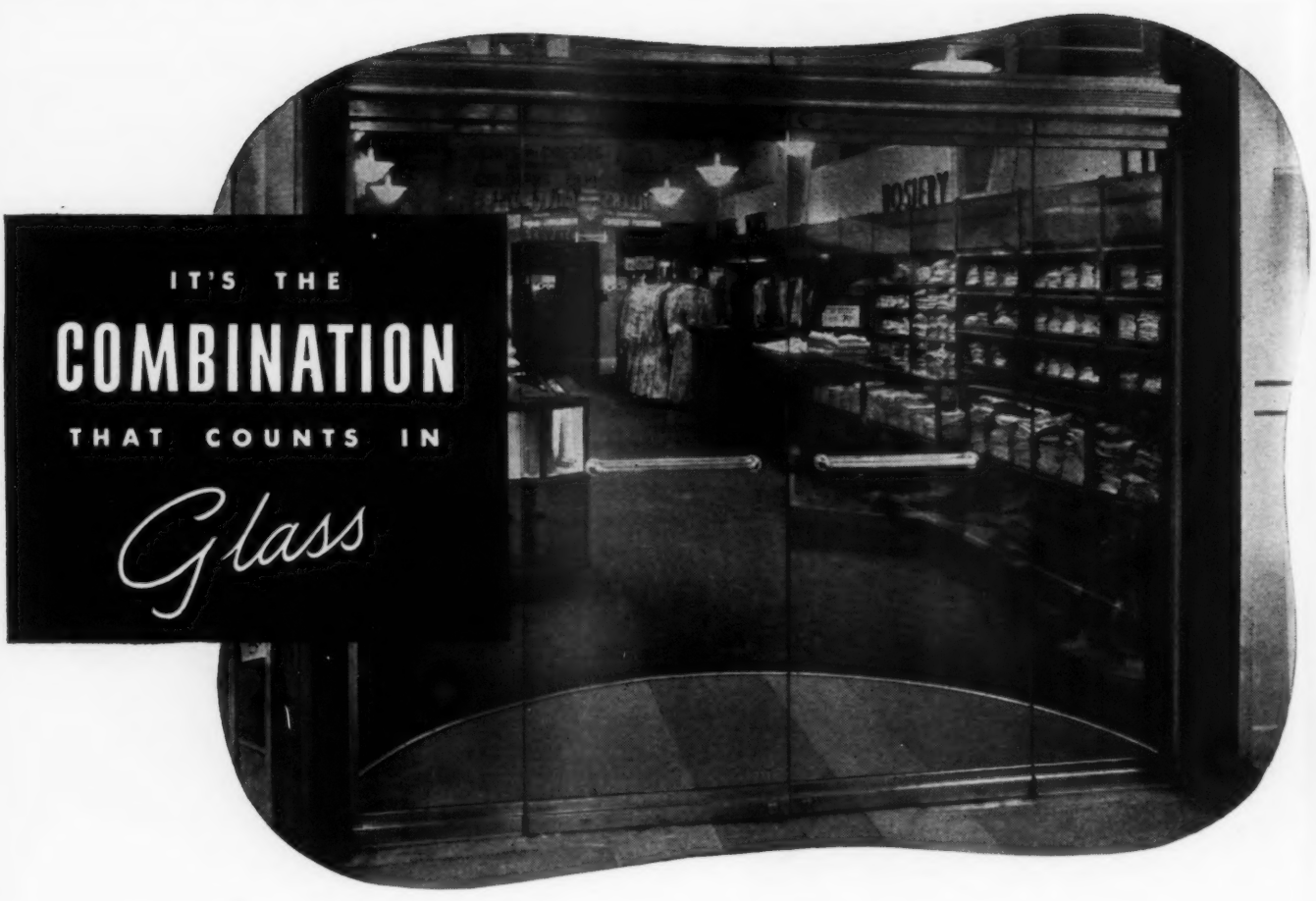
We have encouraged, and will continue to encourage, uninhibited use of Kennametal. The products shown on this page illustrate a few typical applications. The resourcefulness of America's designers and inventors will constantly bring forth new devices in which the incorporation of Kennametal is indispensable to provide wear-resistance up to 100 times that of steel.

To these creative people, in whose minds the material progress of society first takes form and substance, we extend the fullest cooperation of our engineering and metallurgical staffs, and the reassurance that—*"There are no strings attached to Kennametal."*

KENNAMETAL

SUPERIOR CEMENTED CARBIDES

KENNAMETAL *Inc.*, LATROBE, PA.



Clear doors highlight important design characteristics

Being transparent, glass doors provide an unobstructed view of today's modern store interior . . . make the store look inviting and easier to enter.

But it takes more than transparency to make a good door. A door takes punishment—sudden jolts from hurrying pedestrians, impacts from heavy packages and kicking feet. It must withstand weather, sudden changes in temperature and humidity!

Glass has a low coefficient of expansion. It won't warp, swell or bind. It *keeps* its lustrous finish. Add transparency, and you can see why modern doors are made of glass. The glass in the doors illustrated above is Tuf-flex, an L·O·F Plate Glass that's tempered for amazing strength and resistance to impact.

Use glass for resistance to weather and abrasion and for dimensional stability. For brilliance and color. For *insolation*, plus *insulation* use Thermopane, the new hermetically-sealed, double-glass unit. We'd like to discuss with you how these characteristics, in combination, can help you achieve new salability and performance standards in tomorrow's products and equipment. Libbey·Owens·Ford Glass Company, 6075 Nicholas Building, Toledo 3, Ohio.

Here's the combination that makes GLASS one of the world's most versatile materials:

CHEMICALLY, the most stable of all materials, except the noble metals. Won't rot, oxidize or disintegrate, plus—

DIMENSIONALLY STABLE. Coefficient of expansion extremely low. Keeps its shape, plus—

SURFACE, among the world's hardest and smoothest. Nonporous, won't absorb odors or moisture. More acid-resisting than any structural material. Unusual resistance to abrasion. Weathering qualities unequaled, plus—

STRONG, tempered glass is stronger than some metals. A square foot, ¼" thick withstands pressure of 45 lbs. per sq. in. and thermal shock of 466° F. Will not burn, plus—

ELECTRICAL INSULATOR of outstanding strength.

L O F **LIBBEY·OWENS·FORD**
a Great Name in **GLASS**

Destructible? **Wood — Metal — Plastics — Glass. No material is indestructible. However, barring unforeseen conditions, no material will fail on a job in which it has been properly specified and engineered. When our application engineers say "Yes", you can be sure about glass.**

Our metallurgical research laboratory and experimental foundry concentrate all their efforts toward the one goal: to make better Bronze Parts for you:

- Closer-grained alloys.
- Precision molds of special sands.
- Automatic pyrometer control of melting and pouring temperatures for greater uniformity.
- Rigid X-Ray control.
- Strength surpassing all previous standards.

Have your designers or engineers consult with us. We have the experience and facilities to meet their most exacting demands.

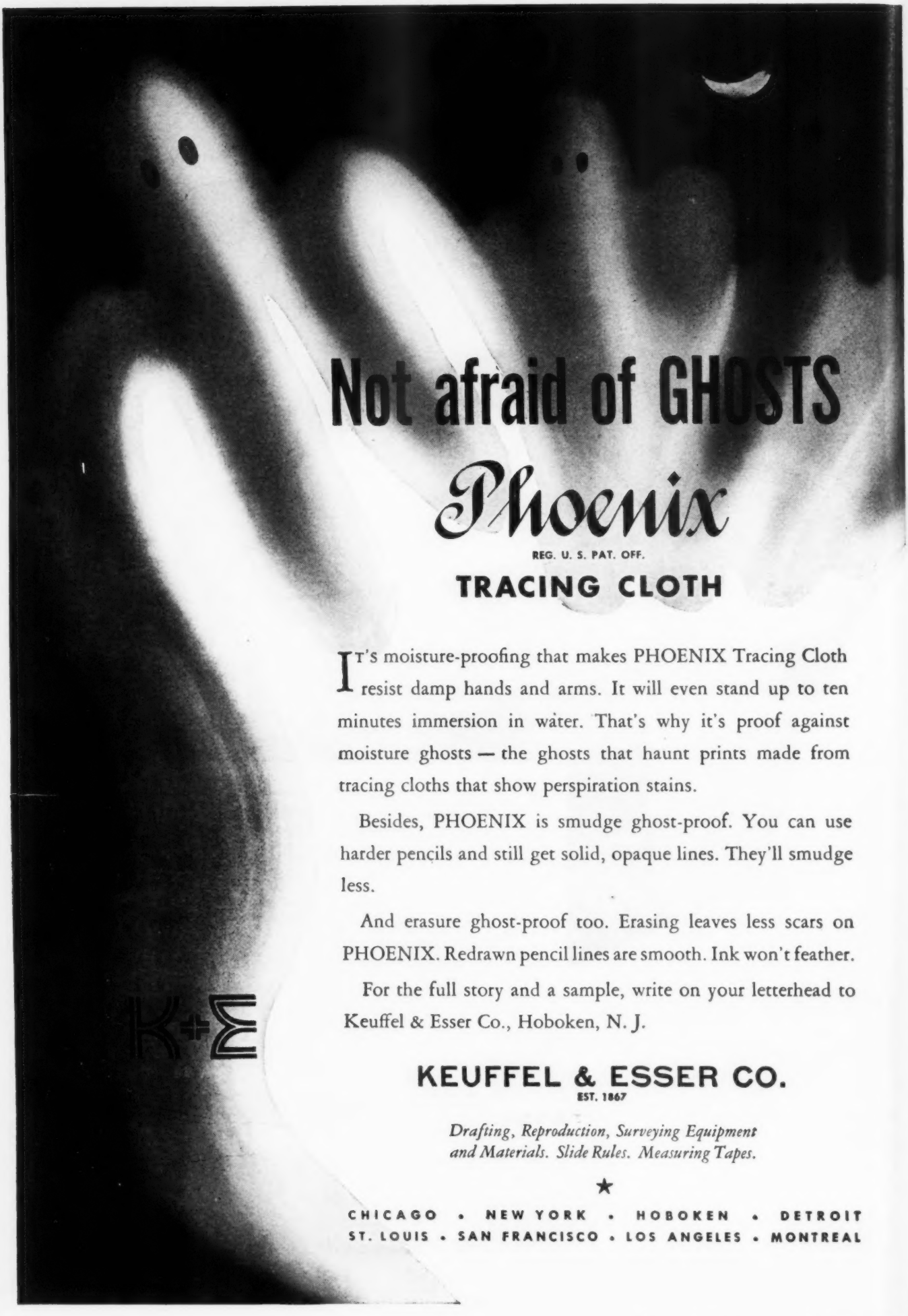
BRAKE SHOE'S RESEARCH GROUP
1 Engineering Laboratory
2 Metallurgical Laboratory
3 Experimental Foundry

N·B·M
BRONZE PARTS

NATIONAL BEARING
DIVISION
ST. LOUIS • NEW YORK

AMERICAN Brake Shoe COMPANY

PLANTS IN ST. LOUIS, MO. • PITTSBURGH, PA. • MEADVILLE, PA. • JERSEY CITY, N. J. • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.



Not afraid of GHOSTS

Phoenix

REG. U. S. PAT. OFF.

TRACING CLOTH

It's moisture-proofing that makes PHOENIX Tracing Cloth resist damp hands and arms. It will even stand up to ten minutes immersion in water. That's why it's proof against moisture ghosts — the ghosts that haunt prints made from tracing cloths that show perspiration stains.

Besides, PHOENIX is smudge ghost-proof. You can use harder pencils and still get solid, opaque lines. They'll smudge less.

And erasure ghost-proof too. Erasing leaves less scars on PHOENIX. Redrawn pencil lines are smooth. Ink won't feather.

For the full story and a sample, write on your letterhead to Keuffel & Esser Co., Hoboken, N. J.

KEUFFEL & ESSER CO.

EST. 1867

Drafting, Reproduction, Surveying Equipment and Materials. Slide Rules. Measuring Tapes.

★

CHICAGO • NEW YORK • HOBOKEN • DETROIT
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TO THE *GEAR USERS* OF AMERICA

Little enough credit has been given the GEAR MAKERS of America for their outstanding contribution to the Gear Industry. Without the consistent, refined accuracy in todays gear construction, "pin-point bombing", "maneuverability", "rapid acceleration", and other overworked trade expressions would still be words instead of actualities.

Achieving this consistent precision requires a constant vigilance over production operations and many leading gear manufacturers have designated Vinco Dual Purpose Gear Rolling Inspection Fixtures—coordinated with Vinco Master Gears, as an essential to successful inspection control. The dual purpose fixture, as the name implies, has the important advantage of checking both the run-out and backlash of the part gear with one Vinco master gear; a Vinco feature that saves time, cuts operating costs and increases production. For a more detailed description write for BULLETIN NO. 91.

MILLIONTHS OF AN INCH FOR SALE BY VINCO

REG. U. S. PAT. OFF.

VINCO CORPORATION, 8867 SCHAEFER HIGHWAY, DETROIT 27, MICHIGAN; SALES OFFICES, NEW YORK, CHICAGO, CLEVELAND

Semi-Automatic Hydraulic Spline and Gear Grinder • Optical Master Inspection Dividing Head • Involute Checker • Angle Tangent to Radius Dresser • Index Plates • Precision Vises • Sine Bars • Straight-side Spline, Serration Spline, Involute Spline and Helical Spline Plug and Ring Gages • Thread Plugs, Rings and Setting Plug Gages • Spur and Helical Master Gears • Munition Gages • Propeller Hub Gages • Built-up and Special Gages • Gear Rolling Fixtures • Spline and Index Fixtures • Hydraulic Power, Control, Utilization and Distribution Units • Engineering, Design and Development.

Provides Fine Bearing Surface

Michigan seamless steel tubing is widely used as raw stock for a variety of machined parts with superfine bearing surfaces. Michigan mechanical tubing is cold drawn to close dimensions with scale-free, smooth surfaces that are easily finished for bearing applications. Often a finishing operation is the only machining required. In addition, seamless tubing is adapted to carburizing or heat treating when necessary to produce desired physical properties. And its uniform grain structure is of utmost importance if parts are to be milled, threaded, drilled, or otherwise machined.

Technical counsel available on request

COLD-DRAWN SEAMLESS STEEL TUBING

AIRCRAFT • MECHANICAL • PRESSURE • STRUCTURAL

MICHIGAN SEAMLESS TUBE COMPANY

SOUTH LYON • MICHIGAN

ARMY E NAVY

Awarded Feb. 12, 1943
First Star Sept. 9, 1943
Second Star May 27, 1944
Third Star Dec. 2, 1944

Snyder Special

HANDLES PARTS of VARIOUS SIZES

This Snyder special-purpose machine is designed to mill lubricating slots in large tapered valve bodies. It is fully adjustable as to the size and position of cuts and will handle parts from ¾″ diameter by 4″ length, up to 6″ diameter by 24″ length. In the job illustrated, four slots are cut, two long and two short.

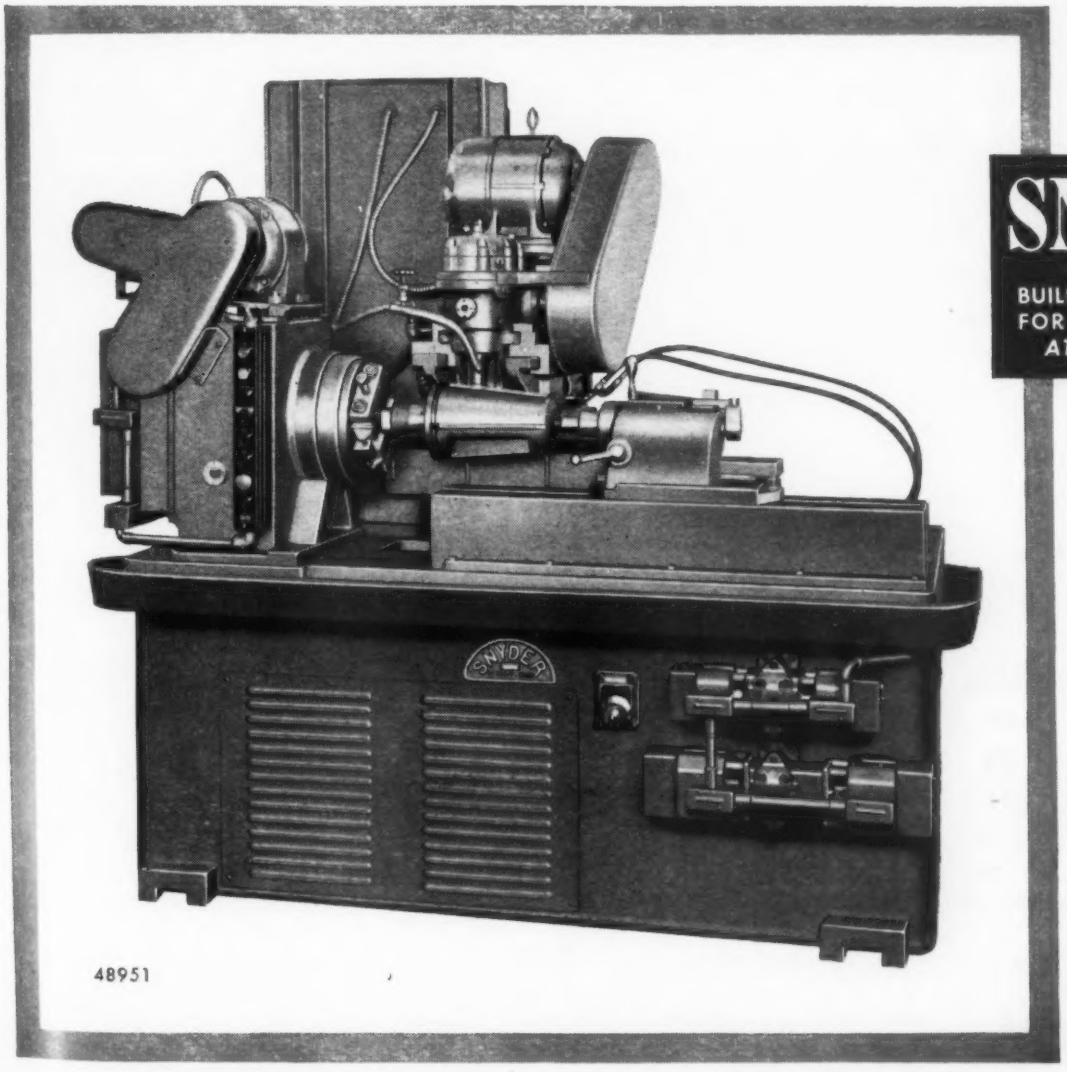
The part is positioned radially from the square end of the valve plug and stem and is held between centers. Indexing is by means of a motor-driven Geneva mechanism which includes a positioning pin and a master control drum governing the travel of the milling cutter head. This mechanism also selects automatically the length of each successive cut.

The spindle housing is installed on a cross slide, adjustable for depth of cut and respective diameter of work and for length of longitudinal feed stroke.

From starting position near the center of the slide the cutter head travels to the beginning of its cut, moves into the work, feeds for the full length of the cut, retracts and returns to center position.

The machine then indexes 90° and automatically selects the next required length of cut and so repeats the cutting cycle until all slots are completed. Hydraulic equipment is in the welded steel base. Coolant tank is separate from the machine.

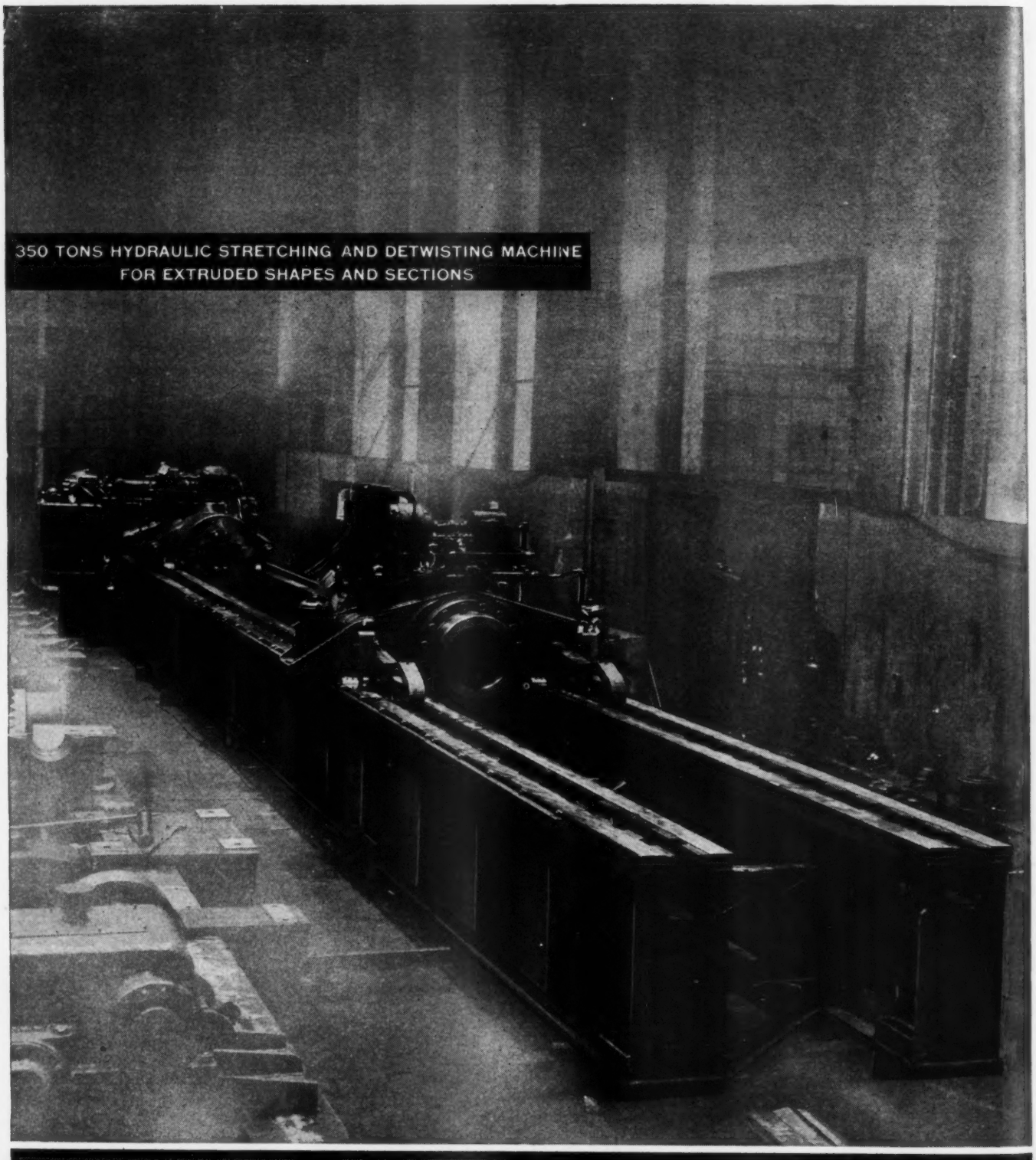
The important benefits of this machine are: variety in size of parts that can be handled, operation by unskilled help, minimum operator fatigue and production increased many times over previous set-ups. Perhaps there are spots in your production line where Snyder "specials" can accomplish similar improvements. We invite your inquiries. *Snyder Tool & Engineering Company, 3400 E. Lafayette Avenue, Detroit 7, Michigan.*



SNYDER

DESIGNERS AND BUILDERS OF MACHINERY FOR HIGH PRODUCTION AT LOW UNIT COST

20 Years of Successful Co-operation with Leading American Industries.



350 TONS HYDRAULIC STRETCHING AND DETWISTING MACHINE
FOR EXTRUDED SHAPES AND SECTIONS

HYDROPRESS · INC.

ENGINEERS *CONTRACTORS*

HYDRAULIC PRESSES · ROLLING MILLS
STRETCHERS · PUMPS · ACCUMULATORS

570 LEXINGTON AVENUE · NEW YORK · N. Y.

INTER-OFFICE MEMORANDUM

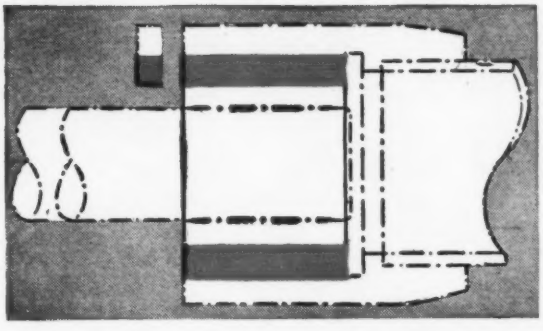
TO

Mr.— Design Engineer
Mr.— Plant Superintendent
Mr.— Maintenance Engineer

INVESTIGATE **NEOPRENE** FOR:

Vibration Dampener
Resilient Motor Supports
Cable Covers

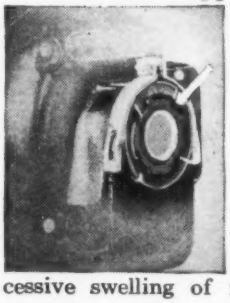
...try Neoprene



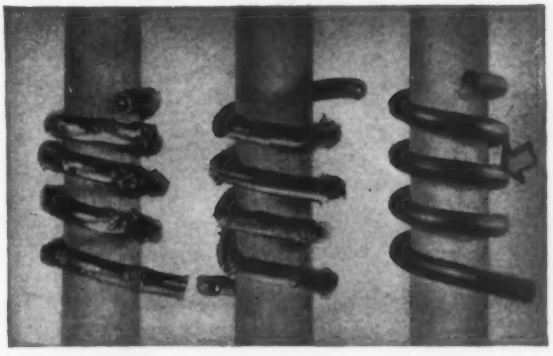
Neoprene Bearing Mounting Controls Overload Automatically

This unusual low-cost resilient mounting for bearings has done a good job of reducing excessive replacement cost due to overload breakage. A neoprene tube is made larger than the annular space between two metal shells. It is inserted by stretching into the annular space and is then allowed to expand so that, at all times, the neoprene mounting presses tightly against both walls of the metal shells. This provides high frictional resistance against slippage. The maker of this bearing selected neoprene because its high resilience was retained when exposed to heat and oil.

Resilient Support for Small Motors



For many years a prominent manufacturer of fractional horsepower motors had used neoprene rings as cushion mountings to give resilient support to the motor and to absorb torque vibrations. Use of oil resistant neoprene solved the problem of excessive swelling of rubber cushions caused by spillage of spindle oil used in the bearings. In addition, neoprene's superior resistance to ozone and oxidation insures a longer service life.



Neoprene Jacketed Ignition Cables Prevent Power Loss

Ignition leaks and power losses were prevented by use of neoprene sheathed ignition cable. Neoprene jackets protected the rubber insulation against deterioration by ozone from the corona effect. Oil-proof, heat resistant and tough, the neoprene jackets continued to protect long after ordinary jackets had cracked and failed.

* * *

Wherever a durable elastic material is required, try neoprene, the most versatile synthetic rubber. Not any one property, but the combination of many desirable properties, makes neoprene the outstanding material to meet severe service. Assistance in its advantageous application for your specific problem can be obtained from the Rubber Chemicals Division, E. I. du Pont de Nemours & Co. (Inc.). Wilmington 98, Delaware.

WAR BONDS PAY OFF IN VICTORY

DU PONT

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

DU PONT NEOPRENE

The Versatile Synthetic Rubber

You can be Sure of Uniformity and Quality when you Specify Globe !

Extra care in production control assures uniformity and quality in all classes of Globe steel tubes. Unvarying quality is safeguarded and production methods and materials exactly controlled by one of the largest and complete chemical and physical laboratories of its kind, concentrating on tubing characteristics and problems.

You can be sure of uniformity and quality when you specify Globe tubes — pressure, mechanical, or stainless.

GLOBE STEEL TUBES CO., Milwaukee 4, Wis., U.S.A.

GLOBE STEEL TUBES

5019

- ★ Pressure Tubes
- ★ Condenser & Heat Exchanger Tubes
- ★ Seamless Stainless Steel Tubes

GLOBE TUBES

- ★ Mechanical Tubing
- ★ Gloweld Welded Stainless Steel Tubes
- ★ Globeiron High Purity Iron Seamless Tubes

WHETHER YOU NEED
PLASTIC PARTS
FOR ELECTRICAL APPLIANCES
OFFICE MACHINES OR INDUSTRIAL EQUIPMENT
Special Handles and Control Knobs for
TOOLS RADIOS AUTOS PLANES
CASES FOR CLOCKS CAMERAS JEWELRY
BATHROOM FIXTURES MEDICAL ACCESSORIES
Or Anything Else that's a Practical Plastic Application
You Get the Job Done Right by

It takes experience, skill and the right equipment to engineer and mold an attractive, perfect-fitting plastic frame for a fine pocketbook—or a beautiful plastic compact—like you see above. Amos has what it takes to do these and numerous other jobs exactly right—the way the customer wants them.

From engineering to finishing, Amos does plastic molding jobs that go into many different fields. Whether it be a large or small component part for some machine or appliance—or an all-plastic product—Amos does the job completely—*and does it right.*

Amos facilities are being greatly expanded. A new plant is about to be completed and equipped to take care of more customers who want their post-war plastic molding jobs done right. Now's the time to get your jobs ready for fast production when materials are available. Just send us your drawings or write us what you have in mind to be molded in plastics.

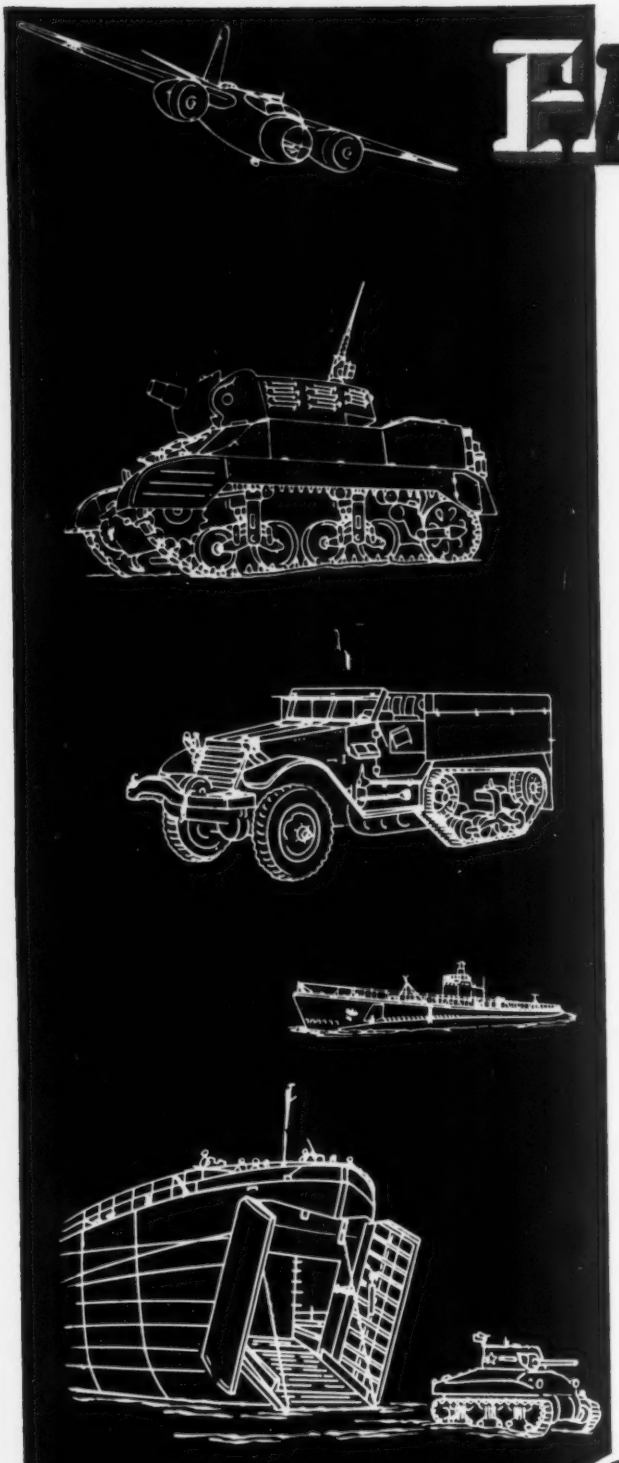
AMOS MOLDED PLASTICS • EDINBURGH, INDIANA

Division of Amos-Thompson Corporation

Amos MOLDED PLASTICS...

CUSTOM Molders of Plastic Parts and Products

INJECTION • COMPRESSION



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Let FABREEKA take the punishment, not the machine . . . FABREEKA will not break down under heavy loadings and severe conditions. FABREEKA keeps its inherent characteristics indefinitely. This means fewer shutdowns for overhaul and repair, thus saving time and allowing more production hours per machine.

5 Principal Characteristics of FABREEKA

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• *Product Engineers and Machine Designers are turning to FABREEKA to solve many problems in the absorption of impact shock and the isolation of transmitted vibration. Write for our Engineering Book:* Fabreeka for Impact Shock, Vibration and Noise.

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Die Casting Division
WOODSTOCK, ILLINOIS

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CHICAGO 5, ILLINOIS

723 New Center Bldg.
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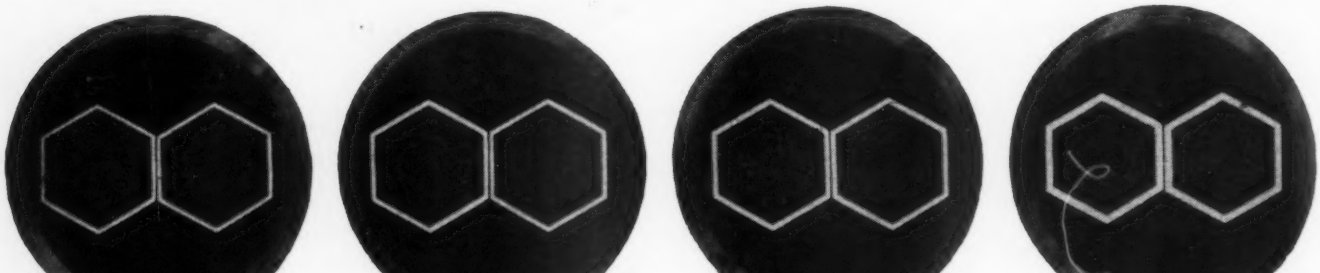
Is Short

CHAPMANIZE

The Fast Way to Surface-Harden Free Machining Steels



IN 1 HOUR | IN 2 HOURS | IN 3 HOURS | IN 4 HOURS

Don't wait around for scarce critical alloys unless their employment in part production is a "must". Chapmanize free-machining steels, and get on with your schedule.

Chapmanizing produces a case of from .015" to .035" deep in from one to four hours—a case so tough and ductile that it won't chip, check or warp.

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Let us send you complete information on this time and money saving process. Write to the Metallurgical Sales Division of:

***The* CHAPMAN VALVE MANUFACTURING COMPANY**

INDIAN ORCHARD, MASSACHUSETTS

IF IT'S A BETTER PRODUCT GIRAFFE-TER . . .

(Can you name all the plastic parts of this "giraffe"? See chart below.)

Please look closely at this giraffe.

He's a lot more practical and useful than most giraffes. The artist put him together out of nine different plastic items all made by Continental's very busy Plastics Division.

His body is a smart-looking phenolic liquid-dispenser; his neck, two phenolic tractor handles. His head is a handle for an air power drill made of cellulose acetate butyrate, while his hoofs are trim compression-made switch-latches.

These items are just a mere handful of the surprising variety of useful plastic products that Continental makes for well-known industrial concerns — plane parts, cams and cogs, impellers and insulators—all of them the result of Continental combining years of experience with greatly increased production facilities and resources. Such a combination means we can bring to bear on your problems an unusual background of knowledge and experience to help you develop better products.

(a) Liquid-dispenser—compression; (b) Tractor handle—compression; (c) Switch-latch—compression; (d) Water-pump impeller—compression; (e) Handle—compression; (f) Molding—extrusion; (g) Pot handle—compression; (h) Knob—compression; (i) Handle for air power drill—injection.

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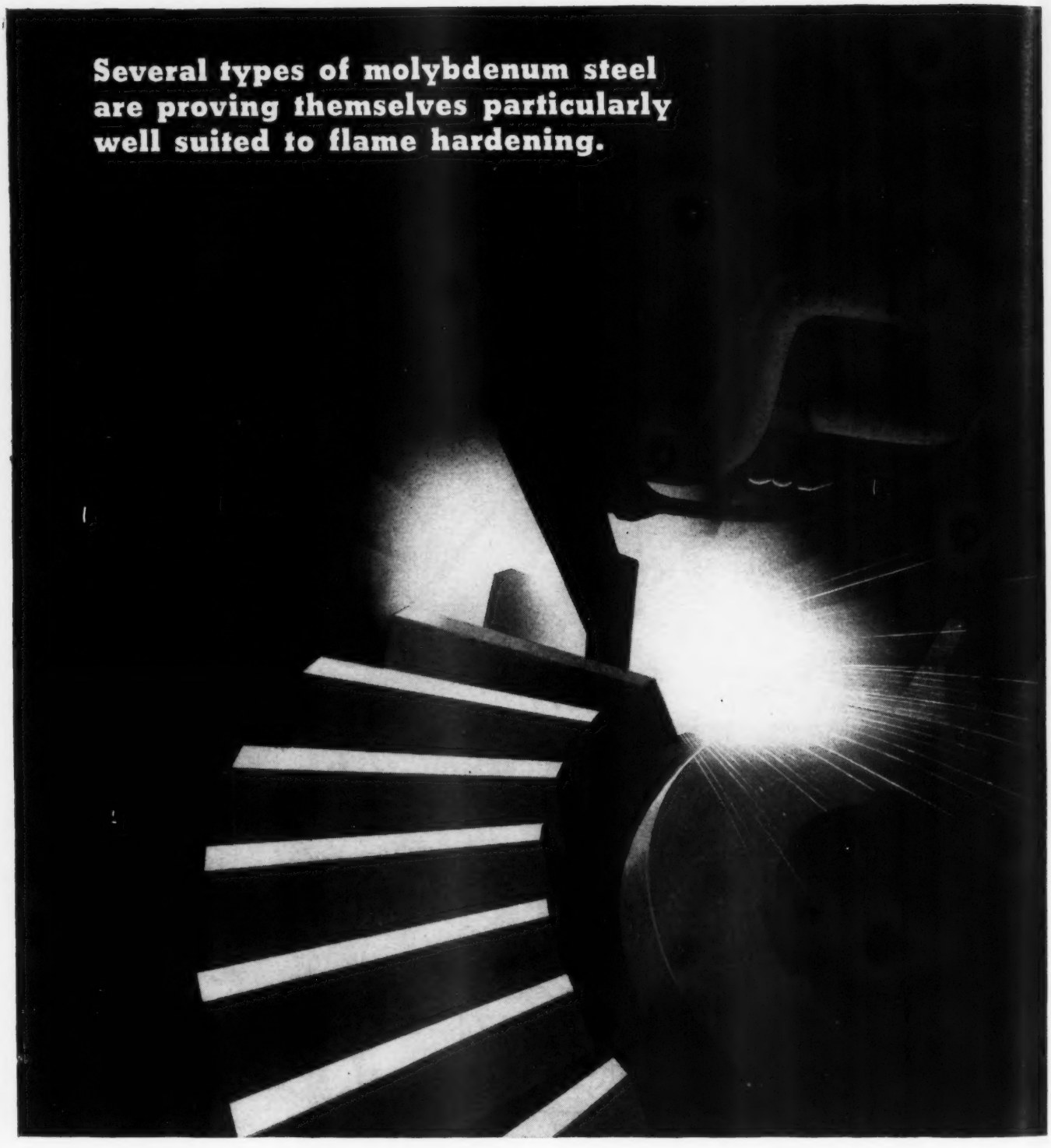

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ARMY E NAVY

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COLD FORMED

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In considering the design of a product or part that can be made from steel sheet, strip or plate, there are definite advantages in using Bethlehem Cold-Formed Shapes.

Bethlehem's complete cold-forming equipment can produce virtually any type and size of section, for automotive and railway equipment manufacturers, shipbuilders, makers of metal furniture, refrigeration, building and highway equipment, and producers of countless sheet-metal articles.

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Cold-forming makes possible a far greater degree of precision and uniformity than is possible with hot-rolling. And the product made from Bethlehem Cold-Formed Shapes will rate high in eye-appeal, thanks to the smooth, well-finished surface which can be given the sheet or strip.

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What about *your* product? Bethlehem's cold-forming facilities may very well help you save money on it. Send for our Booklet 176, describing and illustrating Cold-Formed Shapes in detail. Write to the nearest Bethlehem district office, or to Bethlehem Steel Company, Bethlehem, Pa.

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plastic-base PALADIN conquers 10 hard-to-finish materials

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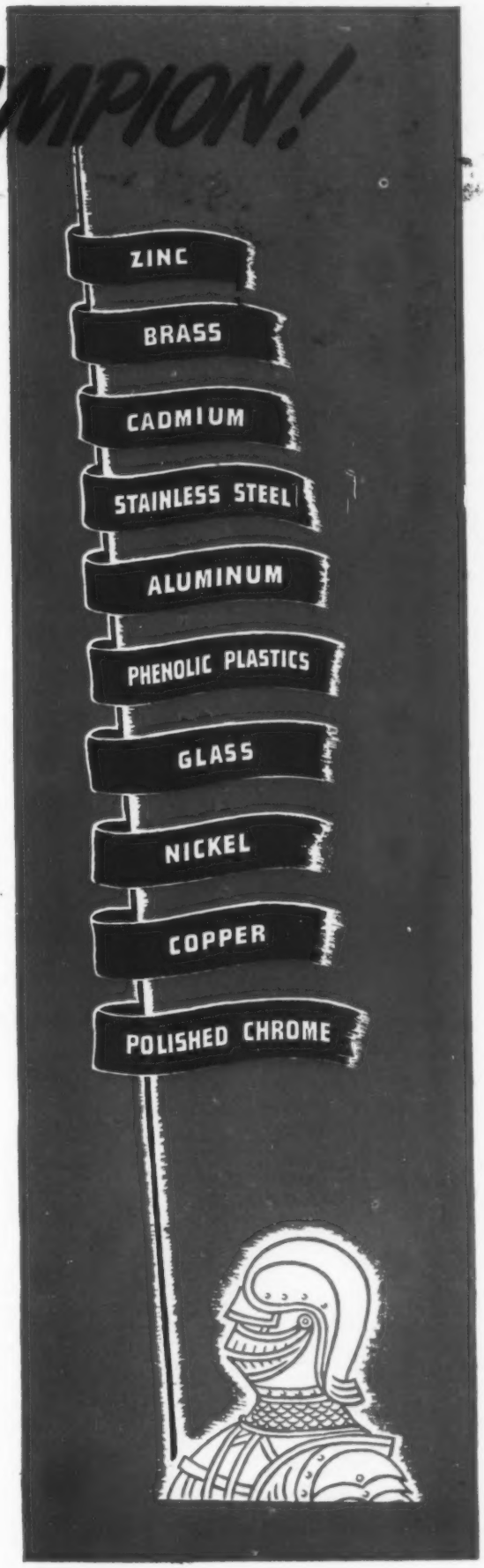
Greater latitude can be given to your designers where it is desirable to use several types of metals in the same product. With Paladin it is no longer a problem to specify a satisfactory over-all finishing schedule. There is a job for versatile Paladin in your plant. Write to Department 806 for technical specifications.



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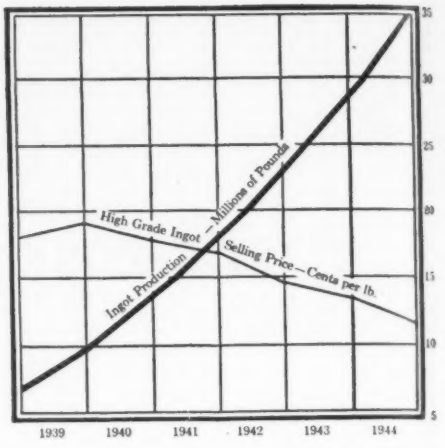

From an average monthly production of Seven Million pounds in 1938, to an average production of Thirty-Five million pounds per month in 1944—that's the 6-year record of growth of the use of Smelters Aluminum Alloys.

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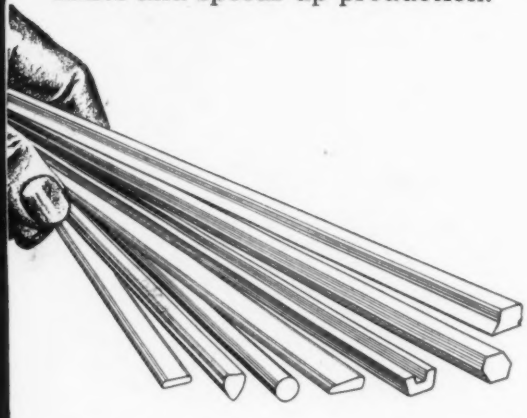

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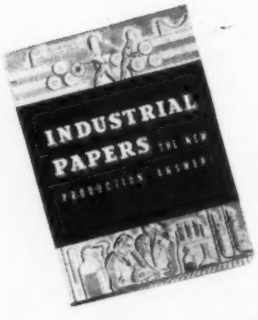

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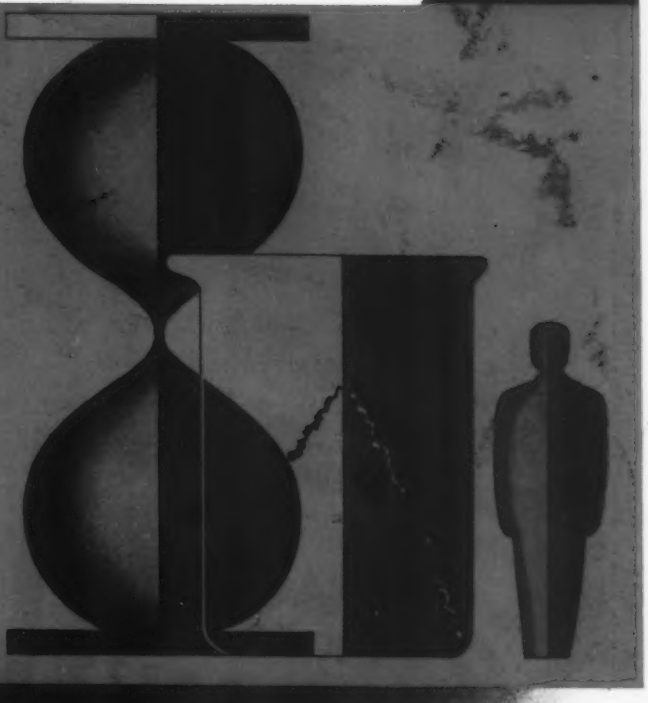

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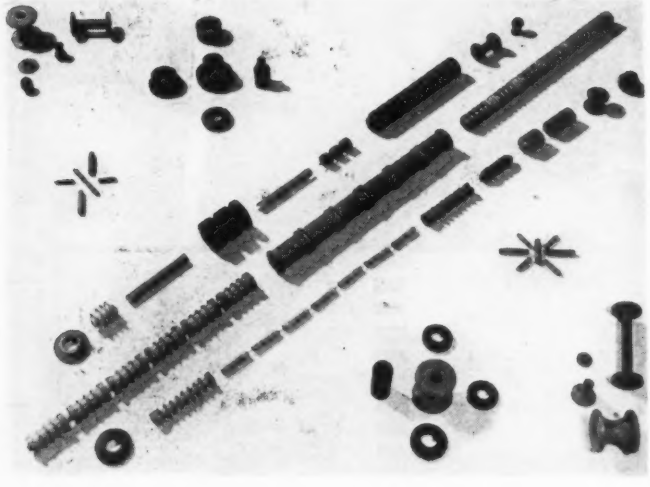

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PLASTICS INFORMATION

YOURS...IN THIS CONVENIENT FILE FOLDER

Our handy-reference Folder is designed to be a useful part of your plastics source file. It contains information on the facilities of our organization for plastics engineering, designing, molding and assembly, and includes examples of plastics applications that may have a relationship to your peacetime products. The Folder is free, on request.

Plastics should be reappraised now in the light of improved methods and materials that have been tested in extensive wartime applications. To help you in your consideration of plastics, send for our Folder File. And call on us early in the design stage of your products. This assures the fullest benefit from our molding experience, and the most practical advantages from plastics.

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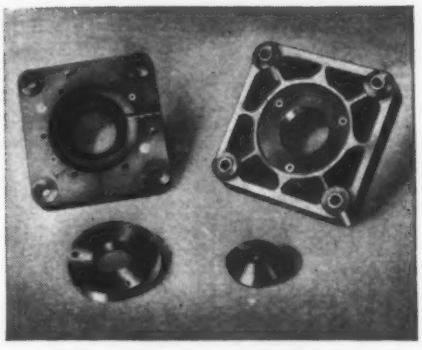
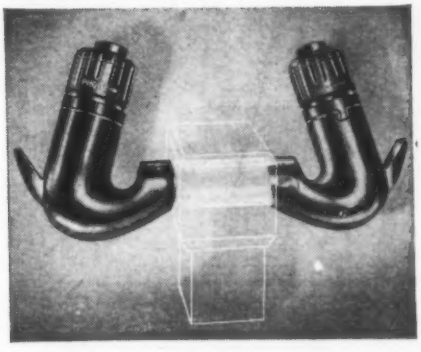
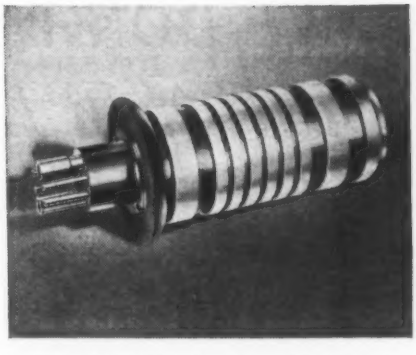


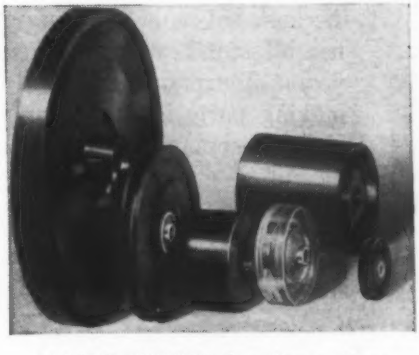
PRECISION MOLDED PARTS



PLASTIC CONTROL GRIPS



PLASTICS AND METALS COMBINED



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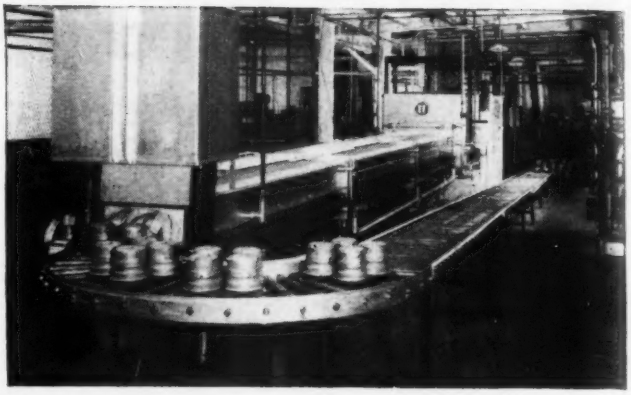

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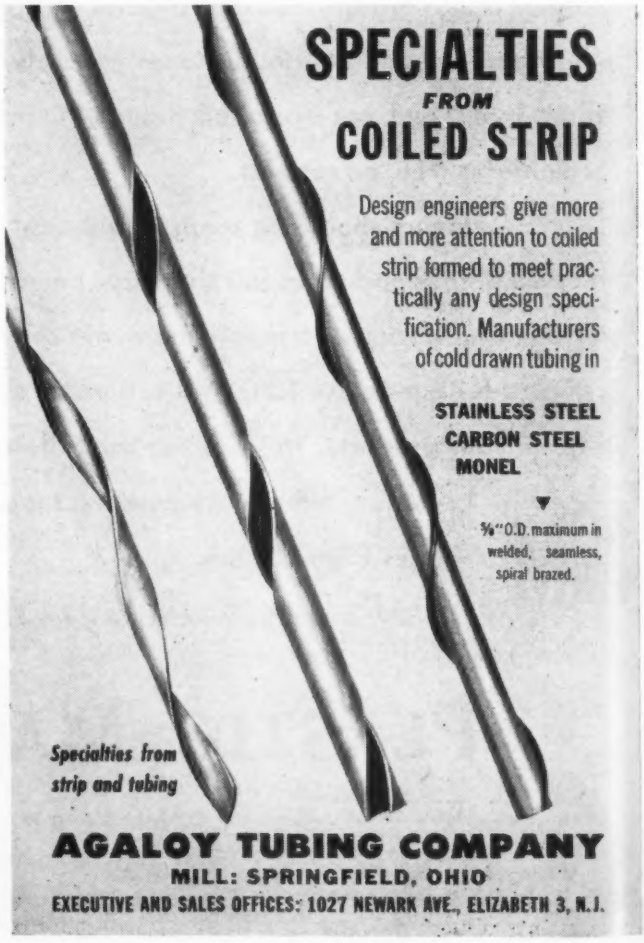
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ALMOST every product of America's high-speed factories includes at least one part created by a pressed metal designer, produced on a metal forming press . . . the Ace In The Whole.

Usually it is this part, made stronger, lighter, more attractive and at low cost, that makes the entire production scheme profitable.

Mullins Press Engineers, with years of experience, always are in the lead in the creation of new metal pressing techniques. Their experience is available to you on request and without obligation.

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DESIGN ENGINEERING SERVICE
LARGE PRESSED METAL PARTS
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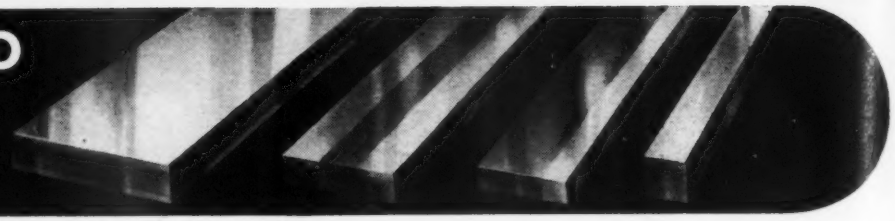
Mullins **can PRESS it from Metal Instead**

LAMINATED PRECIOUS METALS



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Gold, silver, platinum and palladium or special precious metal alloys laminated to base metal have made these things possible . . .

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- **Uniform maintenance of lamination ratios with no porosity, pit marks or defects.**
- **Finer, more lasting finishes than are otherwise obtainable in base metals.**

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To assist you in the application of *our products* to *your products* we are maintaining a staff of thoroughly experienced metallurgists, chemists, designers and consultants . . . an up-to-date research and testing laboratory . . . and a splendidly equipped tool room. These are all at your service to cooperate with your own staff to the full extent of our facilities.

Your inquiries are cordially invited. Ask, too, for a copy of our new descriptive folder.

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NEED SMALL, INTRICATE METAL STAMPINGS TO CLOSE TOLERANCES?

GOAT *Precise-Formed* METAL STAMPINGS

HOW GOAT SAVES YOU TIME AND MONEY

Goat specializes in the design and fabrication to close tolerances of small, intricate, drawn, formed, stamped metal and alloy parts. Expert tool design, quality control, and modern manufacturing techniques can save you time and money on parts like those illustrated above.

ENGINEERS SEND US YOUR PROBLEMS

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AN AFFILIATE OF THE FRED GOAT CO., INC.

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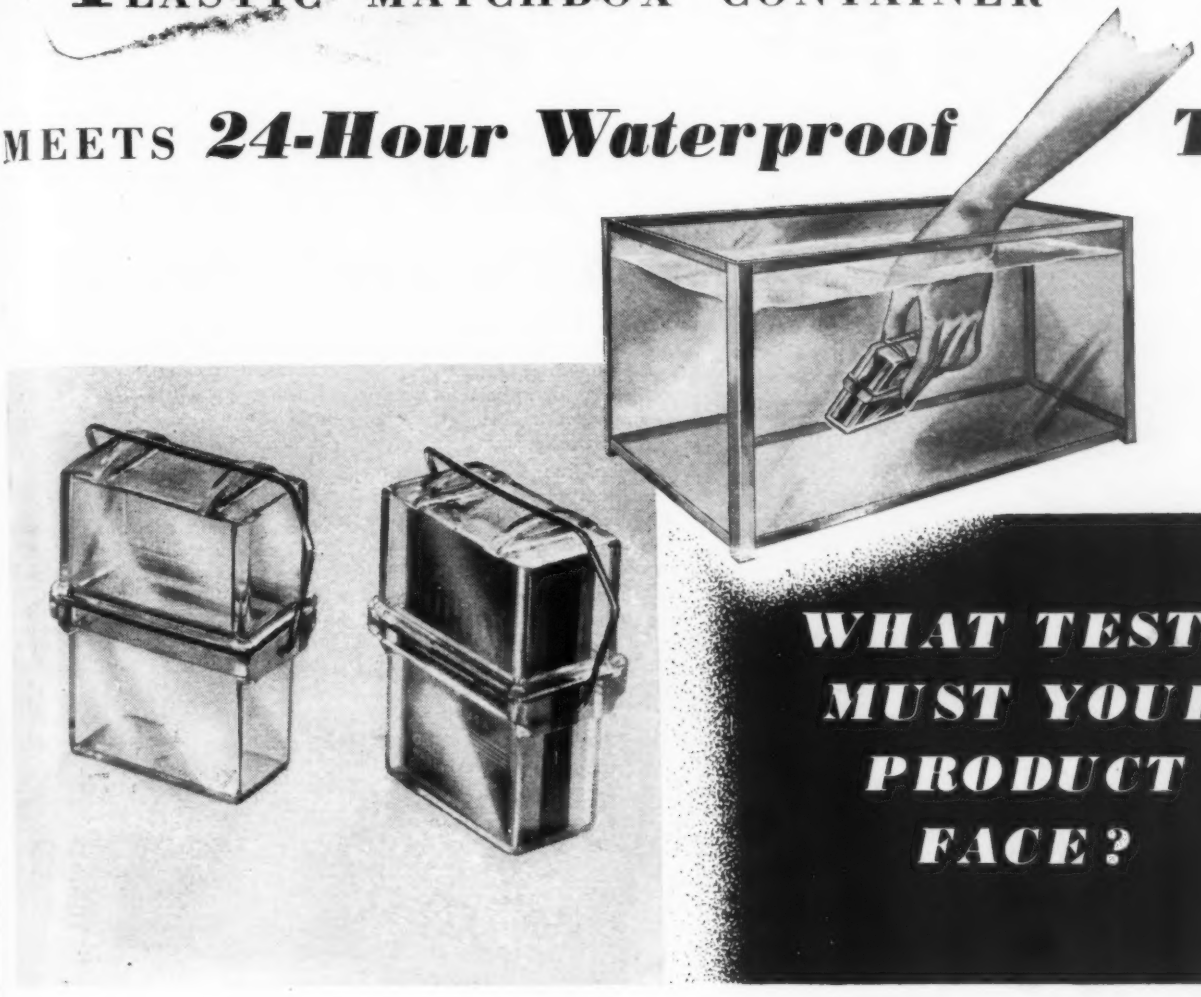
MEETS *24-Hour Waterproof* *Test*



WHAT TESTS MUST YOUR PRODUCT FACE?

The waterproof plastic matchbox container shown in the illustration is a good example of STANDARD MOLDING engineering to meet specific service conditions. Even the metal bale tension device to hold the gasketed seal in compression is STANDARD designed.

Whatever tests your product in plastic must meet, STANDARD MOLDING of Dayton offers expert engineering assistance in coordinating design with function. Give us the service conditions and let us submit suggestions. Our engineers have wide experience in the skillful designing of injection-molded plastic products or parts to meet the most exacting precision specifications.

Take full advantage of the talents and facilities available to you at STANDARD MOLDING—a service as near as your telephone. Call Dayton or the branch office nearest you.

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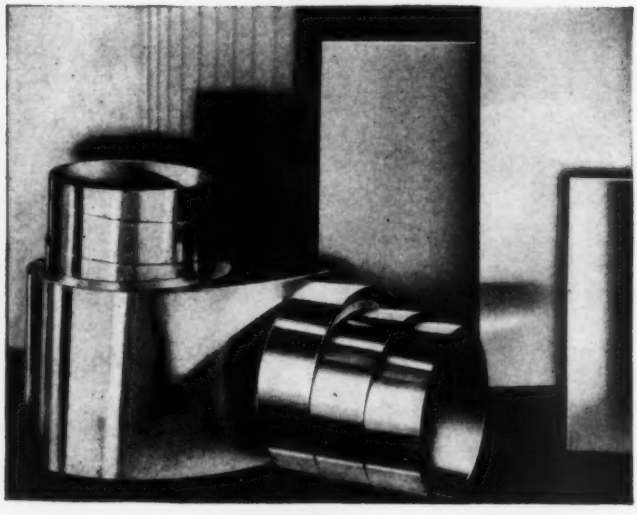
STANDARD SMC MOLDING *Corporation*

460 Bacon Street, Dayton 1, Ohio — Telephone HEmlock 8307

DO YOU SEE WHAT WE SEE



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● **WHAT YOU SEE in Nickeloid Metals is brilliancy of finish . . . inexpensive basic metals plated with a permanent and durable finish that lends eye appeal and sales appeal to a product. WHAT IS HIDDEN — what we would like our representative to tell you more about — is the way that Nickeloid Metals fit into your post-war production program. Economy of basic material is there. So is ease and speed in fabrication. But Nickeloid Metals offer more than that . . . they offer the opportunity of stamping parts that are ready for assembly or shipment, without finishing operations such as plating, painting or polishing. *Write for data.***

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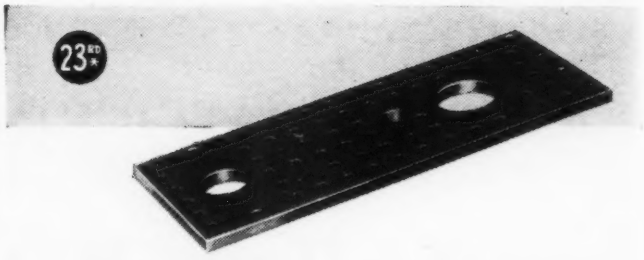


M.P.* on duty in the South Pacific

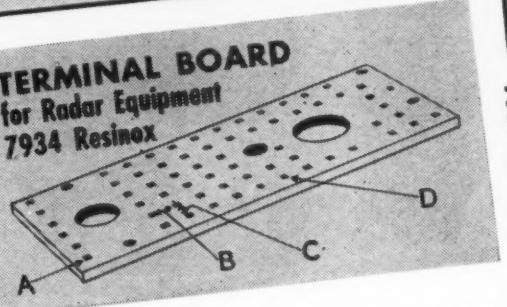
THIS **molded plastic* terminal board is guarding the efficient operation of radar equipment against attack by tropical fungus.

Like many other wartime plastic applications, it is helping reduce maintenance time by increasing dependability and efficiency of component parts.

It is manufactured from material carefully selected for the necessary electrical and chemical properties, and is expertly molded to excel in performance.

Requirements of the part design make this an unusually difficult piece to produce. But, in more than 29 years of precision molding, Aico has gained the technical skills and mastered those processes which are demanded to produce intricate parts to rigid specifications.

TERMINAL BOARD for Radar Equipment 7934 Resinox



7934 RESINOX RADAR TERMINAL BOARD

MOLDING MATERIAL
7934 Resinox, a mineral-filled phenolic, is especially suited for use in electrical equipment, having high dielectric strength and good power factor. Adequate tensile and flexural strength and excellent resistance to chemicals, water and heat are other requirements met by this material.

MOLD DESIGN
This plastic part is produced in a 2-cavity semi-automatic compression mold. Square holes (A) must be accurate and uniform in size and held to close tolerances as to size and position. Distances (B&C) between holes must be uniform in every case.

MOLDING PROBLEMS
Difficulties of molding this part arise from the design requirement of the numerous small square holes (A). Pins in the female mold, which form the holes, must be kept in perfect alignment to match the holes in the male mold. Sharp corners (D) in square holes were difficult to mold because they restrict material flow. Strains set up in molding have a tendency to cause cracks at the corners (D) of these square holes (A) making the part difficult to produce. Aico, with thorough knowledge of molding techniques, overcame these difficulties to produce a strong, accurately molded part that meets all functions and physical requirements.

**Send a request on your letterhead for Aico's file card series, Nos. 1 to 23, covering a wide variety of plastics applications.*

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29th Year

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Take this Diesel injector nozzle as an example. The fine orifices in the spray tip are precision-drilled to exact tolerances to insure proper fuel injection. Yet unless these orifices are safeguarded against clogging or enlargement by harmful particles in the fuel, the benefits of precision manufacturing are lost.

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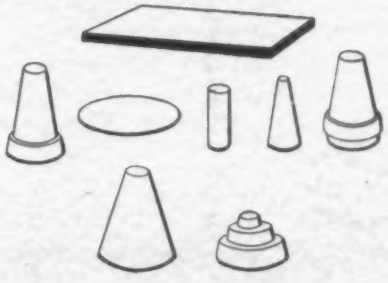

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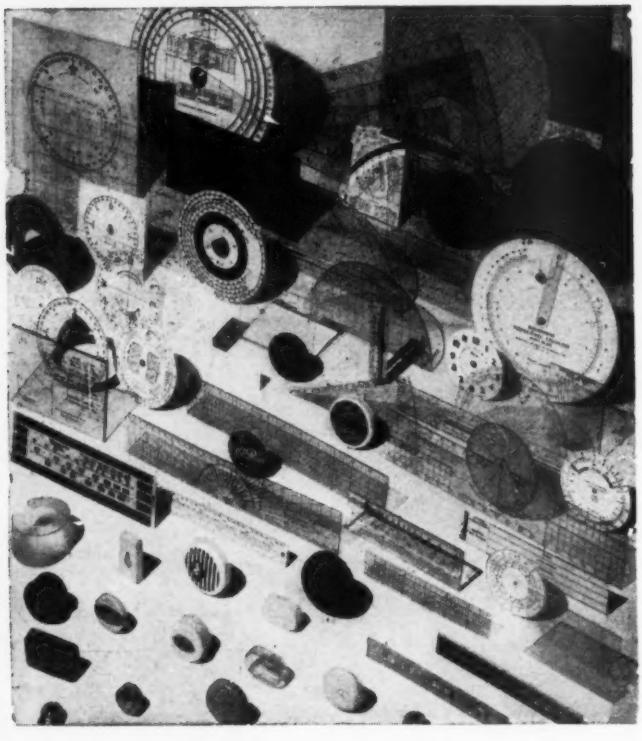

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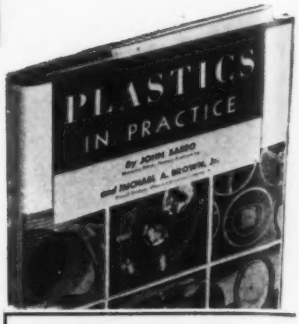
Get your data on PLASTICS from 102 proved commercial applications



To go ahead in designing, merchandising, or developing new products, you want information on properties of available plastic materials, on methods of fabrication, design, and finally on cost. This is just the kind of sound information which two pioneers in plastics bring you. In 102 specific case studies of successful commercial products, they give you an estimate of all types of plastics and the fabricating methods in use today, and their future possibilities.

—materials
—methods of fabrication
—properties
—design
—cost factors

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Managing Editor, **Product Engineering** Monsanto Chemical Co.

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The book gives you

—a working knowledge of plastics
—an intensively-studied review of present and probable future uses of plastic materials
—an idea of the relationship of plastics to metals and other material
—information on the place of plastics in your particular line of activity

A brief introductory section sets up a frame of reference on the various types of plastics, methods of forming, comparative properties and cost factors; then 102 detailed case studies describe how plastics have been adopted in answer to a series of specific problems.

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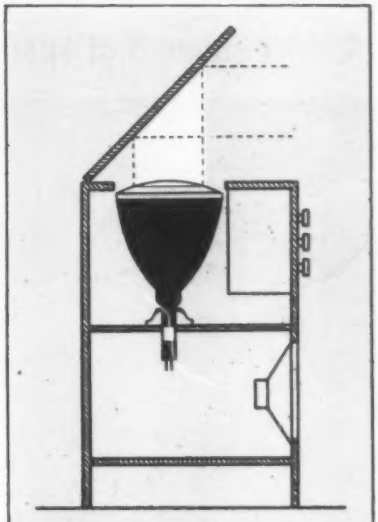
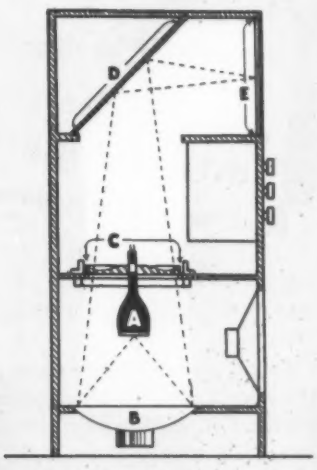


THE OLD WAY. Relatively small. With a direct-viewing cathode-ray tube, 12 inches in diameter, the picture you saw in prewar models was about 9 x 7 inches.



THE NEW WAY. Larger, clearer. By reflecting the rays from a spherical mirror (see diagram) and using a correcting lens of "Lucite," a tube only 5 inches in diameter produces an image which fills a screen 21⅓ x 16 inches, and with greater clarity. The reflective optical system, lens and sets developed by RCA Laboratories to be produced after the war by RCA Victor Div. of the Radio Corp. of America.

This Lens Projection System utilizes a brilliant image on the face of the cathode-ray tube (A) projected down on the spherical glass mirror (B), then reflected up through the "Lucite" correcting lens (C) on a flat mirror (D) which throws a focused image on the translucent viewing screen (E)

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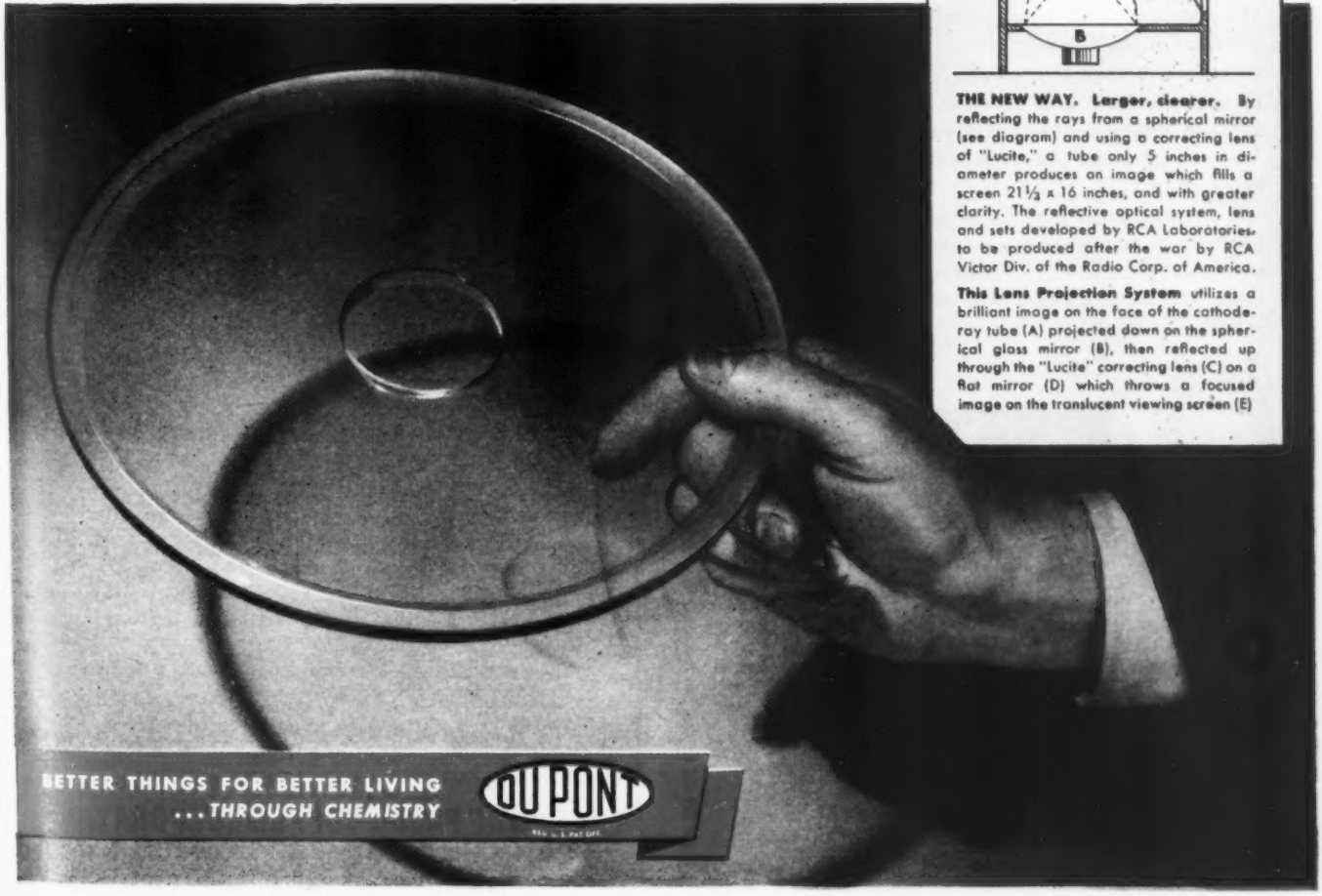

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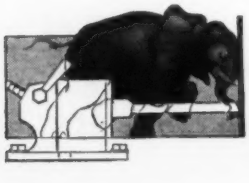

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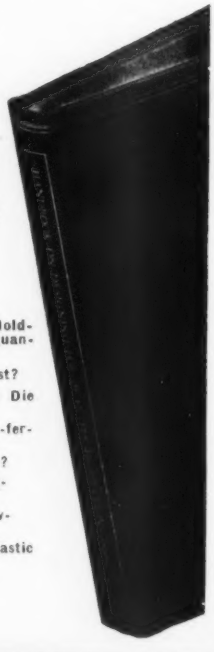

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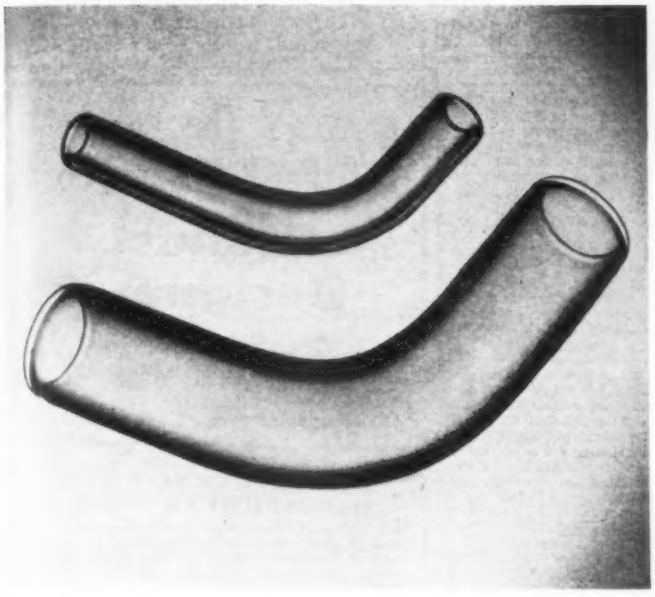

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(Additional Position Vacant ads on pages 365-366)

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10 Different types of prints can be made with Ozalid

You specify the type of print desired—whenever you want reproductions of your engineering drawings, office forms, or other originals.

For some jobs, you may prefer a black-line print to a blue-line or red-line print. Or you may prefer the reproduction on cloth, instead of on paper, foil, or film.

Each type of print has its advantages.

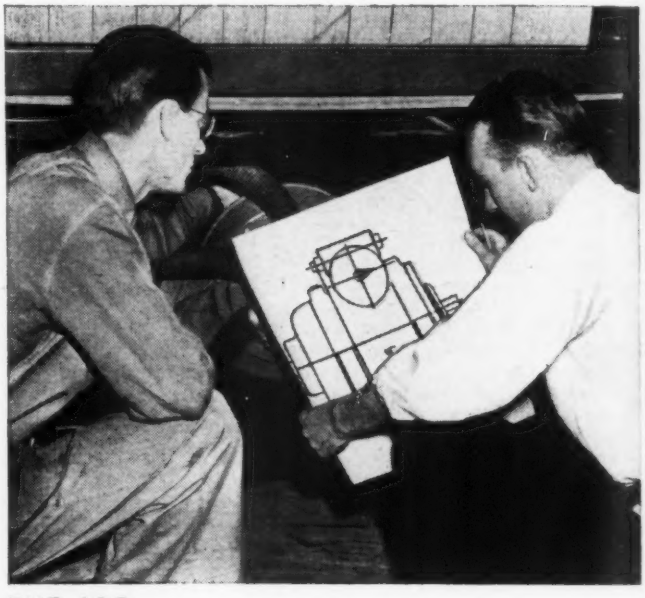
But no matter what type of print you choose, it's made in an OZALID MACHINE in the same manner, in seconds . . . for OZALID is a unique reproduction process which, besides giving you a 10-1 advantage, greatly simplifies printmaking.

THE JOB

Sixteen copies of this three page, typewritten report are needed right away.

The Ozalid Print for the Job

OZALID RAPID BLACK because you'll get prints which you will think were actually typed . . . and they'll be smudge-proof besides. You can also copy form letters . . . and type in headings that will exactly match the printed images. In addition, OZALID RAPID BLACK may be used for all-purpose work.



THE JOB

Part of this design must be changed before production can begin.

The Ozalid Print for the Job

OZALID TRANSPARENT CLOTH because an extremely durable "intermediate" print is desired. The obsolete lines on the print can be removed with Ozalid Corrector and the new design drawn in. The Transparent Cloth intermediate is then used to produce the desired number of prints for the production line.

THE 10 TYPES OF OZALID PRINTS

For efficiency in routine jobs • For "impossible" jobs

1. **Black-line**
2. **Blue-line**
3. **Red-line**
   For routine prints in drafting room, shop, or office.
4. **Opaque Cloth**
   For exceptionally durable prints, file copies, etc.
5. **Transblack Intermediate**
6. **Sepia-line Intermediate**
7. **Transparent Cloth**
   For producing "intermediate originals" or to save time and labor when making design changes.
8. **Transparent Foil**
   For making composite prints; reclaiming old, or worn originals.
9. **Chartfilm**
   For producing lustrous, black-line prints on white plastic base—oil proof and waterproof.
10. **Dryphoto**
    For high-quality reproductions of any photographic subject: in black, sepia, or two-tone effect.

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Division of General Aniline and Film Corporation
Johnson City, N. Y. Ozalid in Canada—Hughes-Owens Co., Ltd., Montreal.

Again and again, thousands of alert engineers like you have proved that they can make their equipment cleaner cut, less expensive, more compact, more productive when they use a power drive that really fits the job exactly.

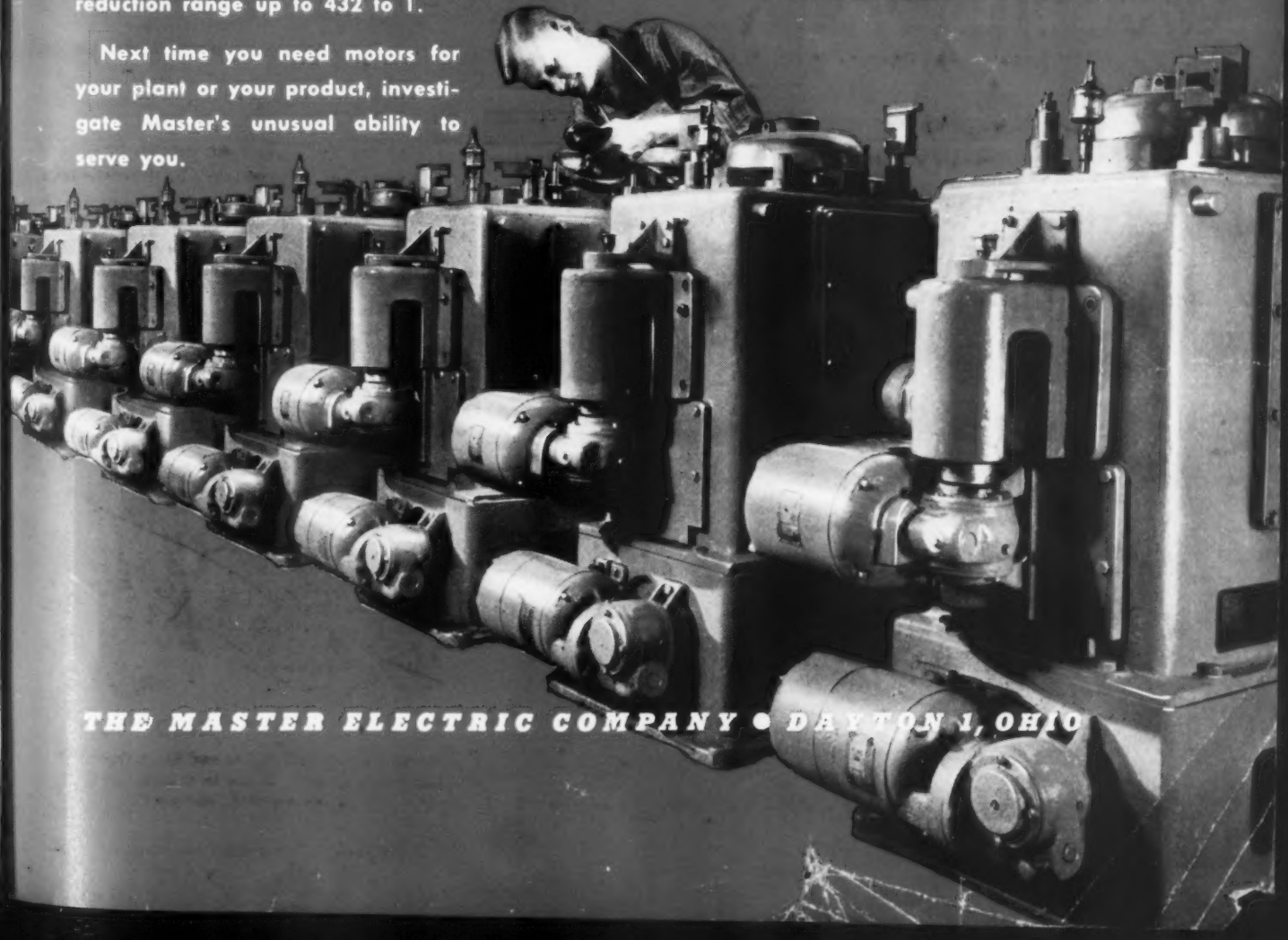
And you'll find it's easier to secure these advantages if you use Master motor drives, because their flexibility and versatility is unmatched anywhere.

For example, look at the motor drives on the machines below. They incorporate a motor and a gear reduction unit and in addition the drive at the bottom also includes an electrically operated brake for quick, controlled stopping. All of these . . . the motor, the gear reduction, and the electric brake . . . all are standard Master units that easily combine into one compact integral power package. Saves ordering and mounting time . . . saves space . . . saves money.

Probably you will not need exactly this same combination of motor features, but Master motors are available in any size from 100 down to 1/10 horsepower and in all cycles, phases, and frequencies . . . in open, splash-proof, fan-cooled, and explosion-proof types . . . with Gearheads, Speedrangers and Unibrakes . . . for every type mounting . . . and over a gear reduction range up to 432 to 1.

Next time you need motors for your plant or your product, investigate Master's unusual ability to serve you.

you can't miss

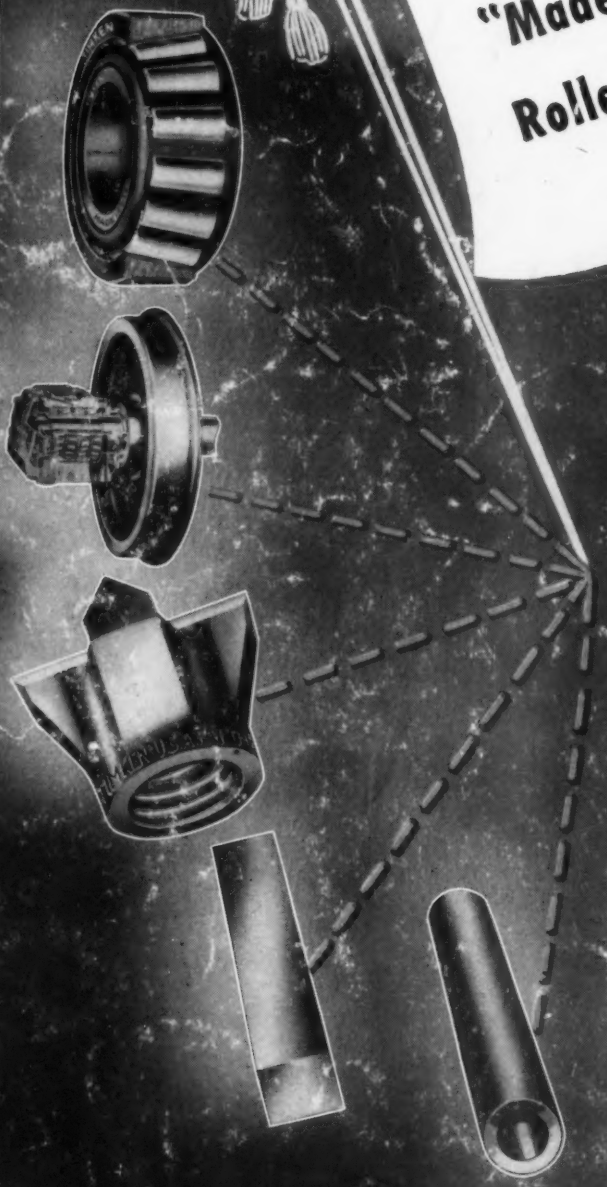


THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

This Trade-Mark Means "Made By The Timken Roller Bearing Company"



Wherever you find it—on tapered roller bearings; alloy steel; seamless steel tubing; or rock drilling bits; it identifies a *genuine* Timken product with all that this implies—superior quality, performance and endurance.

These inherent advantages are not visible; they are revealed only in service, but you can be sure of getting them in full by making sure that the trade-mark "TIMKEN" is on every tapered roller bearing, every bar of alloy steel, every seamless steel tube and every rock bit you buy.

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